THURSDAY, APRIL 19, 1888.

SCIENTIFIC PROGRESS IN ELEMENTARY SCHOOLS.

A VERY remarkable Report has been received by the London School Board from a Special Committee appointed by it a year ago "to consider the present subjects and modes of instruction in the Board schools, and to report whether such changes can be made as shall secure that children leaving school shall be more fitted than they now are to perform the duties and work of life before them." [1]

The Committee, of which Mr. William Bousfield was chairman, was a strong one, representing well the various sections of the London Board. It has produced a Report of twenty-one folio pages, including no less than thirty-one recommendations, and followed by voluminous minutes of evidence given by scientific men and others, who have paid attention to elementary instruction, teachers of special subjects, inspectors, *employés* of the Board, working-men representatives, and others.

This important document is the outcome of several movements. The London Board has, throughout its existence, endeavoured to promote the teaching of science by means of systematic object-lessons; and has made several attempts to give a more practical turn to the instruction. In December 1884, a previous Special Committee reported on technical education, affirming the principle that it was not the duty of the Board to attempt to teach any particular trades, but that it was its duty so to direct the education of its scholars that they could easily take up any special work afterwards, and suggesting various ways by which this might be promoted. Since then the conviction has rapidly grown in the public mind that the teaching is too bookish; the supremacy of the three R's has been rudely assailed; and many people have asserted that other things, such as Lord Reay's three DR's (drill, drawing, and 'droitness), are equally important.

The Report—starting with this definition of education: "the harmonious development of all the faculties, bodily and mental, with which the child is endowed by Nature,"—points out the deficiencies of the present curriculum. It has an earnest paragraph on moral education, and makes various remarks upon the present teaching of history, geography, social economy, and art. But its main criticism is "that the physical or bodily side of education, including the development of muscular strength, of the accuracy and sense of colour and proportion of the eye, and of the pliancy and dexterity of the hand, is almost entirely neglected; and that the mental or brain work, which occupies the great bulk of the time in schools of all kinds, is composed far too much of appeals to the memory only, resulting, at the best, in the retention in the child's mind of a mass of undigested facts, and far too little of the cultivation of intelligence." The Kindergarten principle is strongly approved of, and the first recommendation is: "That the methods of Kindergarten teaching in infant schools be developed for senior scholars throughout the standards in schools, so as to supply a graduated course of manual training in connection with science teaching and object-lessons."

These, then, are the two main directions of progress that are indicated—the knowledge of Nature, and the power of work; the development of the perceptive faculties, and the education of the senses—and these two are to go hand in hand.

Object-lessons are common in elementary schools, but much is said, both in the Report itself, and in the evidence of Sir John Lubbock and other witnesses, in regard to their improvement, and the importance of good collections of objects. Yet it appears from the appendix that only about forty minutes per week on an average are actually given to these lessons in boys' and girls' schools, and we know from the Annual Reports of the British Association on the teaching of science in such schools that the present regulations of the Government Code are actually diminishing the amount of the teaching of geography and elementary science. The Special Committee, therefore, very properly recommend that application be made to the Education Department to grant more freedom of choice in the selection of class-subjects; and that the provision for object-lessons, and lessons on natural phenomena, should be taken into account in boys' and girls' schools in assessing the merit grant, as is the case at present with infant schools. The Scotch Code has within the last few weeks allowed that either elementary science or English may be taken as the first class-subject, which is a hopeful sign of progress. The favourite scientific subjects taught at present in the London schools are animal physiology and algebra; but the Special Committee favour the teaching of mechanics and the fundamental notions of physical science by means of special teachers on the peripatetic plan; and they recommend "that the teaching of all subjects be accompanied, where possible, by experiments and ocular demonstration, and that the necessary apparatus be supplied to the schools."

As to manual instruction, it exists in infant schools wherever Kindergarten exercises are practised, but in boys' schools there is often no practice of the kind except in writing. In London, and perhaps in most large towns, drawing is generally taught, and it is universally allowed that this is at the very foundation of technical instruction. The Committee recommend "that all manual instruction should be given in connection with the scientific principles underlying the work, and with suitable drawing and geometry." Drawing to scale is invaluable for teaching accuracy in work. But drawing does not give the best idea of form, and there is a conventional element about it which puzzles little children. Hence modelling in clay is also recommended. The Board started a class for the use of tools in carpentry at Beethoven Street School, Kensal, but the outlay was disallowed by the Public Auditor. Six such classes, however, are being carried on at the expense of the City Guilds Technical Institute. There is little doubt that the present disability will be shortly removed, and that eventually a work-room or laboratory will become an essential part of every large Board school. How best to give manual instruction is still a matter of discussion and experiment. Good observations about it will be found in

[1] "School Board for London. Report of the Special Committee on the Subjects and Modes of Instruction in the Board's Schools, with Appendices." (Hazell, Watson, and Viney, 52 Long Acre.)

the evidence of Mr. Henry Cunynghame, Mr. Davis, of Birmingham, and Profs. Unwin and Perry. Mr. Ricks, one of the Board inspectors, has drawn out an elaborate scheme for the development of the Kindergarten system throughout all the standards of a school in the directions spoken of.

Girls are more fortunate than boys in the matter of manual instruction. They are taught needlework universally, and very often cookery. The latter may be considerably extended. Domestic economy also in its various branches should be taught, through practical work, and with reference to scientific principles—as in washing, laying fires, and ventilating rooms.

But how is time to be obtained for the introduction of this perceptive and practical instruction? On that point the Committee are very distinct, and there is a singular unanimity among the witnesses that the attention now paid to spelling and grammar is excessive, if not educationally worthless. There is a curious table, too, in the appendix, which gives the results of inquiry as to the subjects of instruction most or least preferred in the various schools. Grammar is so unpopular with both boys and girls that it almost always attains that bad preeminence. Spelling or dictation comes second. In fact there is no doubt that the children dislike what they feel does not add either to their pleasure, or their real knowledge. It is proposed "that the time now given to spelling, parsing, and grammar generally, be reduced."

There are two points on which we should have liked to see some recommendations of a more vigorous character. The one refers to the teaching of arithmetic, which as laid down by the Code is thoroughly unscientific. The other point is this: there are recommendations in regard to evening classes, the more extended use of the pupil-teachers' schools, and the grouping together of the upper standards of several schools in poor neighbourhoods; but this might have been carried much further, and have included the establishment of such valuable institutions as the central schools which are doing such good work in many of the provincial towns, especially in the North of England.

Nevertheless, these recommendations, if they are all allowed to take effect, will mark an era in education. The Special Committee are happily able to add: "It is significant that these changes are demanded alike by educational theorists, teachers, men of science, leaders of industry, and statesmen, and it rests with the Board to carry them into actual fact." The Bill of Sir Henry Roscoe, and that on technical education which is promised by the Government, must also have an important bearing on the scientific development of elementary instruction. We await the results of the discussions that must ensue with the deepest interest.

THE NERVOUS SYSTEM AND THE MIND.

The Nervous System and the Mind: a Treatise on the Dynamics of the Human Organism. By Charles Mercier, M.B. (London: Macmillan and Co., 1888.)

THE time may come when the psychological historian will be required to trace the genealogy and career of such terms as "molecular movement," "discharge," "explosion," "unstable matter," as applied to mental operations, as well as the familiar expression "environment." Whoever else may have contributed to their use, they will be traced back in the main to Herbert Spencer. When once the brain was recognized as the organ of mind in a special sense, chiefly through phrenological observations in which Mr. Spencer was himself at one time engaged (he was, if we mistake not, a member of the London Phrenological Society), the physical basis of mind was naturally described in terms applied to material bodies and employed in physics. The combination of atoms forming molecules being regarded as the fundamental element of the substance of the nervous system, molecular movements were correlated with mental operations. Every corpuscle in the gray matter of the convolutions of the brain was regarded as "a reservoir of molecular motion." It followed that the destructive molecular changes of which the granular protoplasm in the corpuscles is the seat were accompanied by a disengagement or discharge of motion. For the purpose of decomposition or waste, the amount of which is the measure of the force evolved, the remarkable supply of blood received by the cerebral convolutions was seen to be necessary; as also for the recomposition or repair which succeeds waste. Spencer drew some of his analogies from chemical explosions, taking for instance the explosion of the percussion cap and powder in a pistol to symbolize the setting up of decomposition in an adjacent ganglion-cell by (in the case of the retina) a disturbed retinal element. He showed that a partially-decomposed ganglion-cell propagates a shock through the afferent nerve to a large deposit of "unstable matter" in the optic centre, "where an immense amount of molecular motion is thereupon disengaged." The transmission of waves of molecular motion through nerve-fibres is compared by Spencer to "a row of bricks on end, so placed that each in falling knocks over its neighbour. . . . Each brick, besides the motion it receives, will pass on to the next the motion it has itself gained in falling."

These and similar propositions have for long become household words. The terms referred to have become a part of psychological, and to a large extent medical, language. One well-known outcome of Spencerian teaching has been its elaborate application to the study of epilepsy, by Dr. Hughlings Jackson, who has been always anxious to acknowledge the source from which he drew his inspiration. Dr. Mercier's book is another stream from the same source. He makes an acknowledgment of similar indebtedness in his preface. We do not think he is justified in his complaint that "the classical works on Mind ignore altogether its association with the body, and study it from a stand-point so purely introspective as to offer no obvious advantage to the alienist, to whom the concomitant disorders of body are so conspicuous and so important." Holding this opinion it became "absolutely necessary" for Dr. Mercier to prepare the present volume. The writings of Bain, Laycock, and Maudsley, no less than Spencer, are nothing if they do not insist upon the association of mind and body. The very last charge that can be fairly brought against these classical works is that they altogether ignore their correlation. The best evidence of the direction and complexion of the teaching of authors of modern works on psychology is contained in Dr. Mercier's statement that "everyone

nowadays admits that the evolution of mind and the evolution of the nervous system proceeded *pari passu*, and indeed are but two aspects of the same process." It is hardly consistent with a further statement that this way of regarding them is not only neglected but "derided and scouted." Dr. Mercier asks for our sympathy for having been for the last ten years as "the voice of one crying in the wilderness." Other voices, however, have for long been heard there, if indeed that can be called a wilderness which is peopled by the number who admit the above-mentioned proposition in regard to the evolution of the mind and the nervous system.

This work expounds Spencerian doctrines with much fulness of diction, and in a style which is forcible, not to say somewhat dogmatic. We find Spencer's illustration of molecular movements from bricks on end reproduced, and we may quote the following passage as a fair example of the author's style :—

"Imagine a brick set up on end. To do this requires the expenditure of force. Now, if the ground is shaken the brick falls, and liberates in falling a force equal to that expended in raising it. Again, imagine a brick set on end with another brick placed across the top of it. The upper brick can now be knocked off the lower, and the force which raised it be liberated, while the lower brick is left standing, with the force that raised it still in store. It is evident that a brick balanced on the top of another one will be displaced by a gentler shake than is required to knock down the single brick. . . . Now suppose more and more bricks are added until we have quite a complicated structure composed of loose bricks. It is easy to see how readily a top brick could be knocked off. . . . Now if we imagine these bricks to be connected to the pile by elastic bases, so that when they have been knocked down they will slowly rise again, with perhaps a little help, to their erect position, we shall have a diagram which will represent very roughly what we suppose to be the mechanism of the nervous discharge" (p. 23).

Dr. Mercier's copious vocabulary clothes an idea in many folds of attire. It is, we think, sometimes overloaded and too diffuse. Endowed with a large organ of comparison, he illustrates his theme with a redundant variety of illustrations or makes one illustration do duty in many forms. Great facility of expression enables him to enforce his views, though it may be at the risk of producing weariness by excessive iteration. He revels in the description of molecules—their form, their relative position, their polarity, their life, their behaviour, and their destiny. M. Renan has been said to know more about St. Paul than the apostle knew himself. Similarly Dr. Mercier would, we are quite sure, be found to know more about the molecules of the brain than, were they gifted with consciousness, they would know themselves. He might write a charming story entitled "The Biography of a Cerebral Molecule." The author divides his subject into three sections: Nervous Process, Conduct, and Mind, the first underlying the other two. In treating of "nervous discharge" he argues that the building up of a molecule implies force; this remains latent, stored up in the gray matter. It is liberated at intervals—that is, during functional activity. The rearrangement of atoms in the molecule may be called "decompounding," while the process of destruction is more properly termed "decomposition." Thus, then, the former, together with the liberation of force accompanying it, is the "discharge." It tends to spread. How is the liberated force replaced? Dr. Mercier cannot tell. All that can be said is that it is a part of the general system of bodily nutrition. Passing on to "nervous resistance," it is assumed that there is a balance of tension and resistance in the gray matter of the brain. The subject is worked out ingeniously, and as fully as it admits of. Necessarily much is altogether inferential. The hypothetical nature of the doctrines taught by the Spencerian school no doubt deters not a few from adopting them. Such persons say that they are not scientifically proved, and they challenge those who insist on their importance to show that they can practically help the physician in his treatment of mental affections. A homely simile illustrates the doctrine of continuous resistance. A charged soda-water bottle resembles the tension of a charged nerve-cell. Withdraw the cork, and the resistance of the narrow neck causes an intermittent escape. The contents "come blobbing out in a succession of intermittent bursts," and so, according to the author, the narrow necks of nerve-cells—the fibres which proceed from them—cause analogous results.

One chapter is devoted to the co-ordination and inhibition of muscular action. Nervous discharges are regarded in terms of the latter. The discharge of an area of gray matter occasions normal movements. The simultaneous beginning, duration, and ending of muscular action depend upon the simultaneous issue of a current of force to each muscle under its influence (p. 67). The nerves of muscles connnect them with the cells of the gray matter of the brain, and muscular force depends upon the amount of nerve-discharge. Co-ordinated movements are secured by the group of nerve-elements called a nerve-centre. The initiatory impulse may come directly from the outside world—the environment. In some instances, however, this action is indirect and distant, as, when reflection ends in acts set going by "currents starting from the highest centres." To terminate the action set up, another stimulus is necessary, unless exhaustion itself terminates it. Here comes in the element of control or inhibition to which all nerve-centres are presumed to be subject, and by which they are retained in a condition of mobile equilibrium as surely as the planets in their orbits by the opposition of attraction to their own inertia. It is forcibly argued that this influence is derived from centres having other functions, and not from one exclusively set apart for this purpose. Inhibition is, in short, a higher degree or power of the resistance which causes the intermittent escape of nervous force. A wide question is here raised, and there is not as yet a consensus of opinion among physiologists in regard to it. "Movements" are dealt with in much detail. The section on the co-ordination of movements is an elaborate study of the subject. In the discussion of the nervous mechanism of co-ordination and inhibition, occasion is taken to give a minute description of Jacksonian epilepsy. In inhibition the centres which supply the impulse to start and accelerate, supply also the impulse which arrests and retards. In walking, for instance, the centres which actuate and regulate it are so arranged that they control those below, they themselves being under the control of still higher centres. If the action of the head-centre is suspended, the local and vegetative functions

are still performed. There is no paralysis. The early stage of drunkenness is a good example. There is the uncontrolled action of the centres usually subordinate to the highest controlling, but now non-functioning, centre. There is in such an instance, "the withdrawal of the stimulus of frequent positive impulses." In later stages there is something more than temporary suspension or inhibition; there is destruction of the highest centres and actual paralysis. Under "Conduct" Dr. Mercier considers the human organism and the environment along with the adjustment of the former to the latter. He carefully follows the lines of Spencer, and points out that the study of mind belongs neither to the first nor to the second, but only to their adjustment.

Our space does not admit of our following the author in his study of the "Constitution of Mind," in which he endeavours, with, we think, imperfect success, to prove that the feelings cannot be disordered without disorderofthe intelligence. Were this theoretically true, so far from having a "practical bearing of great moment," it would be an instance of an abstract theoretical proposition being, strictly speaking, true, while for all practical purposes experienced alienists tell us they find it necessary to admit a moral insanity with an average amount of intelligence. Alienists will no doubt discuss this and other conclusions stated in the third part of this work, and we leave the task in their hands. The most original portion of the work is that in which Dr. Mercier classifies cognitions and feelings, dissenting as he does from the classification of Spencer in several important particulars, upon which we cannot enter.

There will, of course, be the same criticism on the position taken by the author as is frequently offered to that of his master. True, there is no denial of mind; on the contrary, emphasis is laid upon the absolute distinction between mind and matter; but the complaint will be made that all the functions of life are explained by the brain's molecular and molar action in adjustment to environment, without taking into account the influence of what is admitted to be "mind"—in other words, thought and feeling. The circle, it will be objected, is completed without allowing for the action of at least one important factor. Dr. Mercier, for instance, writes to this effect:—"He who gets himself vaccinated is procuring a change in his constitution adapted to the existence in the outside world of the contagium of small-pox. He is procuring the adjustment of his organism to a set of conditions in his environment." What, asks the objector, is the position of the "he"? In what relation does this personal pronoun stand to the organism? How is it possible to ignore it in the explanation of mental manifestations, or what is called the adjustment of organism to environment?

Dr. Mercier advances no further than his predecessors in enabling us to answer these questions. It does not help us to insist upon the "fathomless abyss" that separates mind from matter. We get no further under his guidance than the "rearrangement of molecules in the gray matter of the superior regions of the nervous system." We are told that no process of change in the latter can cause a change of consciousness. To Dr. Mercier's mind this is "unthinkable"; therefore it is not to be thought of. Equally unthinkable is the proposition that a change in consciousness can cause a change in molecular arrangement. The two changes are, it is said, invariably simultaneous. No doubt, as the author says, the student who grasps these notions has half his difficulties surmounted. To overcome difficulties, however, by evading them and confessing our ignorance is somewhat dispiriting, and some would think pusillanimous. Dr. Mercier, while granting the existence of mind on the one hand, and movements on the other, will neither allow of such expressions as "psycho-motor" nor give us an equivalent; for the terms he himself employs exclude the mental factor altogether, although he is forward to admit its existence. There is a break in the circuit, and yet the latter is presented to us as if it were complete. On the remaining links of the chain, the work before us is a painstaking and connected, and therefore valuable, dissertation. If this missing link can only be postulated, and cannot be brought within the range of practical psychology, it must be acknowledged that the science is defective in a most essential particular. If the relation between mind and matter is unthinkable, it is not alleged that mind is so, and therefore there does not seem to be any scientific objection to the employment of terms which recognize some causal relation between mind and matter. Still less do we find in the employment of such terms the "blasphemy" which so painfully grates upon the psychologically tender conscience and rigid orthodoxy of our author Seeing, moreover, that there is an appreciable lapse of time between an idea or willing, motion, the whole of which need not be occupied in the transmission through nerve-fibres, there seems at least as much justification for using the term "ideo-motor" as many terms which describe or imply a theory which, like Dr. Mercier's own hypothesis, is confessedly inferential. And further, the expression may be, like a host of others, defective in comprehensiveness and precision, and yet be the most easily understood.

In conclusion, we would say that Dr. Mercier's work may be read with profit by the class for which it is intended, so long as it is understood that it treats of only one aspect of the relations between mind and body, and so long as it does not obscure the recognition of those great truths of cerebral physiology and mental pathology, which are not in dispute, and the teaching of which will continue to enlighten the student of psychology, when the theories of the philosophers are exploded or forgotten.

POPULAR METEOROLOGY.

L'Atmosphère—Météorologie Populaire. By Camille Flammarion. (Paris: Librairie Hatchette et Cie., 1888.)

THIS is a re-issue of a popular work that first appeared in the year 1872, and which has been enlarged and brought up to date.

Of all the subjects which are interesting not only to men of science but to people in general, there are few more important than that of the atmosphere, since, without its aërial envelope, our planet would pursue its path round the sun in silence and without life, as is the case with our moon, which bears evidence on its surface of nothing but death and desolation. The existence of an atmosphere makes all the difference in the world to a

cooled star; for, with one, its life is stirred up by millions of beings of various kinds which are always changing, by trees and shrubs and different kinds of plants which adorn its surface and supply man and beast with the food and nourishment necessary to sustain life.

Again, when we consider that, of the myriads of meteorites which people space, twenty millions, with weights varying from tons to the minutest possible specks, are met with by the earth every twenty-four hours, a new function of the atmosphere is revealed, for owing to its buffer-like action they fall harmless, and indeed almost unperceived, on the surface of our planet.

Since a knowledge of the atmosphere and its laws must be of more *service*—though not of greater interest—to those whose lot it is to sail the ocean than to those who sit at home at ease, no country should foster meteorology with more gladness than England, so many of whose subjects are under the influence of the "vital fluid," which the author gives as a definition of the atmosphere.

The volume is divided into six books, each of which contains about eight chapters. In the first book is described the atmospheric envelope, the method of determining its height and chemical composition, finishing with a chapter on sound and the history of the invention and development of the balloon which was tried at Paris in 1884, with some most interesting descriptions of ascents which from time to time have been made, including a table of the highest inhabited places, highest mountains, and the distribution of the various species of birds as regards the height to which they fly.

Light and the optical phenomena of the air are next dealt with. Reflection and refraction are first discussed, followed by the beauties of sunrise and sunset, the grandeur and magnificence of which it is almost impossible to describe. . We find that not enough mention is made of the absorptive power of the atmosphere which produces at those times all the most beautiful colours. A very interesting phenomenon is here referred to—a total eclipse of the moon with the sun still above the horizon, which is brought about solely by the refraction of the atmosphere.

Then follow illustrations and descriptions of all the various kinds of rainbows, halos, and mirages which have been seen both on land and at sea.

The third book, which is by far the largest and most important of all, is on temperature. When we come to consider the enormous amount of solar heat that is poured on to the earth's surface, we may have some idea of the work which our atmosphere is continually doing for us. The atmosphere, as the author says, is in truth a huge machine, on whose action everything on our planet which has life is dependent. There are in this machine neither wheelwork, pistons, nor cogs, nevertheless it does the work of several millions of horses, and this work has for its end and effect the preservation of life.

Next we come to the waters of the earth, which play one of the greatest parts in the working of the atmosphere. All day long, and every day, water is being carried away from the earth's surface in the form of vapour, and it is chiefly in this way that the action of the sun's rays on the face of our planet is reduced. The amount of water evaporated each year, as the author states, amounts to 721 billions of cubic metres. The enormous quantity of heat which has produced this effect could melt per year eleven thousand millions of cubic metres of iron, a mass whose volume would exceed several times that of the Alps. Following this are some very interesting chapters on the seasons, containing a great many tables of the highest and lowest barometric and thermometric readings which have been taken at various places, concluding with an account of the distribution of the temperature on the surface of the globe.

The wind and general circulation of the atmosphere are the subjects of the next book, including a chapter on ocean currents, showing how the wind is influenced by them. The course of the Gulf Stream, which plays such an active part with the climate of various places, and is the most important of all currents, is here described, with a map showing its course and that of various other currents. The atmosphere, as we know, is threaded with winds, as the sea is with currents, some of which are more or less constant, others variable. But there are still other kinds of winds, especially those that characterize certain countries and certain parts of the ocean, which are more violent and destructive than the ordinary kind, such as cyclones, the simoom, &c.

In the next book the various forms and kinds of clouds are described, and illustrated by splendid coloured plates, which give very good ideas of their form, with the results obtained by M. N. Ekholm, of Hagström, of the heights of the various forms of clouds. This will be read with great interest in connection with Mr. Ralph Abercromby's latest observations.

Electricity and the various forms and ways in which it appears in our air are discussed in the sixth and last book; the aurora, the most curious and most beautiful of all forms which are assumed by it, being fully treated. These wonderful displays, which are seen to perfection in the Polar regions, and which during the long winter there tend to change its monotony by shooting forth brilliant rays of light, and illuminating a region which would otherwise be in darkness, are here described in a graphic manner, woodcuts and coloured plates illustrating the various forms they assume.

The concluding chapter is on the prediction of weather —a subject which at the present day is carried on to such a great extent, and which to a country such as ours is invaluable in giving us warning of storms that would otherwise come upon us and do much destruction.

The volume is thoroughly well written. It is profusely illustrated throughout, and there are fifteen plates printed in chromotypography and two hand-coloured plates. No pains seem to have been spared to make it an intellectual and enjoyable book; the object having been to produce a work giving a broad outline of the various causes of every-day occurrences in the atmosphere.

W. L.

OUR BOOK SHELF.

Life in Corea. By W. R. Carles, F.R.G.S. With Illustrations and Map. (London: Macmillan and Co., 1888.)

THIS is a valuable and interesting account of a country about which little definite knowledge has hitherto been accessible. There are some aspects of his subject with which Mr. Carles does not profess to deal. Apart from such incidents as happened before his own eyes, he has

nothing to tell us about the system of government, or the relations between the king and his nobles, the people and the serfs, in Corea. On the other hand, he gives a full and sometimes a very vivid account of everything he himself had opportunities of directly and carefully studying, and his book is worthy of serious attention, mainly because it consists of the results of his own personal observation. Mr. Carles went to Corea for the first time in 1883, when he not only visited the capital, Soul, but undertook, with some friends, an interesting journey inland. The object of this excursion was the inspection of a silver working, which proved to be very unworthy of its reputation. The scenery, Mr. Carles says, never failed to charm, and the people were invariably civil. At Soul he had some difficulty in obtaining anything really characteristic of native taste and skill. In the curio shops the only distinctly native article seemed to be a kind of iron casket inlaid with silver, the pattern of which was sometimes very delicate. In the spring of 1884, Mr. Carles took up his quarters at Chemulpo as H.M. Vice-Consul in Corea; and one of the best chapters in the book is that in which he sums up his impressions of Chemulpo and the neighbourhood, bringing together various facts of scientific interest, and indicating problems as to tidal and other phenomena about which he is still uncertain. In this chapter Mr. Carles offers a suggestion which is certainly worthy of the attention of men of science. He says:—

"With so much of interest on all sides, I could not help regretting that no information was ever asked for by the outside world on points which the opening of Corea would be likely to clear up. It seemed impossible that one could not be of use to some science in collecting facts which had hitherto been unattainable; but apparently consular officers are not consulted except on commercial questions. If scientific men would follow the example set by Chambers of Commerce, and ask for information which they expect to be within the reach of out-of-the-way posts, they would generally confer a boon on the officer by giving him a new special interest, and they might sometimes learn what they sought for."

Early in September 1884, Mr. Carles received instructions to undertake a journey along the high road from Soul to China, as far as the frontier town of Wi-ju; then from Wi-ju eastwards across the mountains to Kong-ge; thence south to Gensan, on the east coast; and from Gensan to Soul. In the course of this journey he watched closely for any indication of conditions favourable to industry and trade, but his observation did not lead him to take a sanguine view of the immediate future of the Coreans. Displaying little enterprise, they are extremely poor, and the prevailing opinion among them seems to be that the Government alone is capable of doing anything for the improvement of their circumstances. At Song-do, the old capital, admirable pottery used to be made, but when the seat of the government was transferred to Soul, the trade fell off, "and the workmen, refusing to follow the Court, gradually abandoned their industry, the knowledge of which has now been forgotten." Speaking of the religion of the Coreans, Mr. Carles says that, although Buddhism has been under a ban during the supremacy of the present dynasty, there is hardly a mountain valley off the main roads in which there is not a Buddhist temple; and often he came across figures of Buddha carved in relief on rocks. Fetichism still survives, and is manifested, among other ways, in the presentation of offerings to particularly fine trees. Mr. Carles gives an account of a conspiracy which caused serious trouble at Soul in 1884; and in a concluding chapter there are some careful notes on the Corean language. The interest of the book is greatly increased by the illustrations, which are mostly reproductions of some paintings in sepia by a Corean artist at Gensan.

Navigation and Nautical Astronomy. Compiled by Staff-Commander W. R. Martin, R.N. (London: Longmans, Green, and Co., 1888.)

THIS book, which has been accepted by the Lords Commissioners of the Admiralty as a text-book for the Royal Navy, is one that has been wanted for some time, as it contains the whole theory and practice of nautical astronomy in one part. The method of arranging the various problems is very good. The theory of a problem is always proved first, then the problem is worked in a theoretical manner, and lastly in the manner used by navigators, so that one gets everything to do with any one problem in two or three pages, whereas most books on this subject are divided into two parts, a theoretical and a practical. The method adopted by Staff-Commander Martin ought to prove a great advantage to all persons using his book, more especially beginners. The work is divided into two parts, the first being devoted to the various methods of fixing ships' positions by the land, and of navigating a ship by what is known as "dead reckoning." In this part also the various methods of chart construction are very fully explained, and it ought to be mentioned, for the information of naval officers, that the examples relating to charts are as much as possible arranged to be used with the "Officers' Atlas," which is supplied to each man-of-war. The examples ought therefore to be of great service to junior officers. The second part treats of the theory and practice of nautical astronomy; the method of arrangement we have already described. The volume is accompanied by the requisite charts and diagrams.

H. C. L.

A. Johnston's Botanical Plates. (Edinburgh: A. Johnstone, 1888.)

THESE are coloured plates, 35 × 25 inches in size, intended for use in elementary schools. In the first instalment of nine plates, members of the following natural orders are shown: Ranunculaceæ, Papaveraceæ, Linaceæ, Acerineæ, Solanaceæ (two examples), Scrophulariaceæ, Corylaceæ, and Liliaceæ. The plants already illustrated appear to have been chosen at random, but when the series is completed a fair representation of the more important orders will no doubt be provided. The plates are well executed and boldly coloured, so that the chief external characters of the plants shown will be sufficiently obvious to the class. Some details of the structure of the flower have also been given, but these figures are rather meagre. Still, this is not a serious objection, as the chief aim of botanical teaching in elementary schools must always be to teach children to know plants by sight. For this purpose these plates, judging from the few already published, seem admirably adapted.

D. H. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Injuries caused by Lightning in Africa.

IN a copy of NATURE published on December 11, 1884 (vol. xxxi. p. 127), I noticed a statement by Herr von Danckelman that in all the publications relating to Africa, accounts of injuries caused by lightning are so rare that he scarcely found any literature concerning the use of lightning conductors or the frequency of accidents caused by lightning in the tropics. After an unbroken residence of twelve years in the Egyptian Equatorial Province, I can give to your meteorological readers a little information on the subject in question, and I venture to submit

the following list of injuries which occurred during the years 1878–86. It must, however, be understood that this is not to be regarded as a complete list of the accidents which occurred, for during the years 1878–80 I was nearly always travelling about, and was therefore unable to collect information of a satisfactory character.

Year.	Name of station.	Lat. north.	Description of accident.
1884 ...	Bor	... 6 12 ...	Man killed; house burnt.
1880 ...	Lado	... 5 1 ...	Tree felled.
1882 ...	,,	... ,, ...	Man killed.
1886 ...	,,	... ,, ...	Two empty houses burnt.
1883 ...	Redjaf	... 4 44 ...	Two men badly burnt.
1886 ...	,,	... ,, ...	Woman killed.
1883 ...	Wandi	... 4 46 ...	Flagstaff felled; man bruised.
1882 ...	,,	... ,, ...	House burnt.
1880 ...	Kabajendi	... 4 37 ...	Storehouse burnt.
1883 ...	Muggi	... 4 8 ...	Two girls killed.
1885 ...	,,	... ,, ...	House burnt; girl paralyzed.
1881 ...	Labore	... 3 55 ...	Two boys killed.
1879 ...	Chor Aju	... 3 48 ...	Tree felled.
1881 ...	Dufilé	... 3 34 ...	House, with sheep, burnt.
1883 ...	,,	... ,, ...	Tree felled.
1883 ...	Wadelai	... 2 37 ...	House burnt.
1883 ...	,,	... ,, ...	House, with calves, burnt.
1878 ...	Magungo	... 2 14 ...	Woman killed.
1880 ...	Mahagi	... 2 2 ...	Flagstaff felled.
1878 ...	Kiroto	... 2 ...	Tree felled.

Captain Casati reports—

1881 ...	Neolopo (Monbuttu) ...	Man badly burnt.
1886 ...	Djuaia (Unyoro) ...	Woman killed.
1886 ...	,, ,, ...	One man killed; one burnt—died in two days.
1886 ...	,, ,, ...	Tree felled near observer's house.

These cases were all observed in our stations, with the exception of two—one occurring in Wandi, in December 1882, and one in Redjaf, in November 1885. They all took place in the rainy, that is to say, in the cooler season. From the list you will see that two or three times every year we suffer some damage from lightning-strokes. It therefore does not appear that these accidents are so rare as Herr von Danckelman supposes, at least in this part of Africa, and if travellers do not report such accidents, it is probably because of their short stay in definite places. I noticed, in Schweinfurth's "Im Herzen von Africa," i. pp. 345–46, that six women were killed by a single flash of lightning. I may be also permitted to remark that in Unyoro and Uganda, countries which have a greater elevation than our own, the frequency of destructive lightning-strokes is much greater. Uganda is the only country boasting of a lightning-conductor. Mr. A. M. Mackay has erected one there, to protect King Mwanga's palace. Monbuttu, too, although having a lower elevation than Uganda and Unyoro, is celebrated for the frequency of accidents caused by lightning.

In more northern latitudes—namely, at Fashoda, Khartum, and Berber—destructive lightning-strokes are nearly unheard of, whilst in Sennar they are not altogether infrequent.

It is curious to notice that the Sudan Arabs have firmly conceived the idea that with every flash of lightning a piece of meteoric iron is thrown to the earth. They believe that whoever is able to secure such a piece of iron has gained a great treasure, because they think that swords and knives made out of it can never be surpassed in quality, and that their possession gives immunity from danger in battle, and affords protection against lightning-strokes. Sheik Nasr, who is the Chief of the Takkala Mountains, is said to have resisted all Egyptian attacks, and preserved his and his people's independence, on account of his possession of such a sword. Another superstition is, that fire kindled by a flash of lightning cannot be extinguished until a small quantity of milk has been poured over it. There seems to be some connection between these beliefs, inasmuch as water is believed to spoil meteoric iron: when working it, the blacksmith uses milk instead of water.

EMIN PASHA.

An "Instructive" Bibliography of the Foraminifera.

UNDER the title of "The (!) Bibliography of the Foraminifera," a remarkable production was published by Mr. Anthony Woodward in the *Fourteenth Annual Report of the Geographical and Natural History Survey of Minnesota* (St. Paul, 1886), and the work has lately been followed by a supplement—one of a series—in the *Journal of the New York Microscopical Society* for January 1888. Had the compiler not issued this supplement, previous criticisms might have sufficed, but, as he has again produced an extraordinary and untrustworthy list, it is incumbent on us to bring the work and its demerits before the notice of those who may be tempted to expect good results from using it.

"The" Bibliography, as it first appeared, occupied some 120 pages of the Minnesota Report, and it was hailed with some satisfaction. When put to the test, however, it was found to be absolutely untrustworthy—dates, pages, volumes, and other important details being incorrect. It therefore became necessary for the worker to see and examine every unknown or new entry, and to correct when necessary. The result fully justified this labour, for the whole thing was soon found to be comparatively useless in its uncorrected condition. To begin with, it was evident from the number and nature of the typographical errors that the proofs had not been corrected. Apart from this, however, there are more serious defects, for which excuse must be difficult. The compiler uses freely Mr. Brady's excellent bibliography appended to the *Challenger* Report on the Foraminifera, but he does more—he reproduces in his lists precisely the same printers' errors that appeared in Brady! It is therefore evident that the American compiler neither saw the books he entered in his lists, nor troubled to verify the entries. Here are a few examples:—

P. 251.—Terquem's papers on the Foraminifera of the Oolitic series. "Pt. 1, in the *Bulletin de la S c. d'Histoire Nat. du Dép. de la Moselle*, 1868; the remainder published by the author." Some of these "remainder" were published in the *Mém. Ac. Imp. Metz*, and it is so stated on the separate copies.

P. 271.—Neugeboren, J. L. Bericht zu den in den Jahrg. LII. und LIII., &c. This is nonsense, it was a printer's error for I., II., and III. In the same entry Brady gives a wrong volume; Woodward does the same!

P. 224.—Reade, J. B. Mr. Brady gives a wrong date; Mr. Woodward copies him, and does the same.

The names of authors form another stumbling-block. Some of these are positively offensive.

P. 196.—Karrer, F., L. F. Pourtales, &c. Two papers, both on the same page in Brady. The paper quoted should read Pourtales, L. F.

P. 218.—King, Wm. This is true, but if the paper had been consulted, the compiler would have found that the Foraminifera were described by Jones, T. R., in King, Wm, &c.

P. 225.—Seguenza. This paper was written by Brady on Seguenza's genus!

P. 226.—Stewardson, G. This author is probably Dr. George Stewardson Brady, F.R.S.!

P. 227.—Thompson, W. Sir C. Wyville Thomson is confused with a somewhat obscure author of fifty years ago.

P. 266.—Jozsef-tol, S. Can one believe that this is the compiler's serious attempt at Dr. Jozsef Szabo, of Budapest!

In all these cases, and numerous others besides, it would have been to the compiler's credit if he had placed "[not seen]" at the end of his entry, for it is surely far worse to acknowledge acquaintance with papers, and to quote them thus carelessly, than to have never seen them at all.

The next offence is the frequent duplication of entries. The following examples will suffice:—

Pp. 228, 229.—Wallich on the Radiolaria as an order of the Protozoa. A reference to the *Pop. Sci. Rev.* would have shown this.

P. 244.—Leymerie, Mém. sur le terrain à Nummulites, &c. Again a reference would have shown these entries to be the same.

P. 268.—Koch, Ueber einigen, &c. The same remark applies to this as to the last, and indeed to all similar carelessnesses.

The quotation of *notices* of papers from various scientific journals, unaccompanied by references to the original places of

publication is a frequent and a grossly careless error, for in every case the information is forthcoming. Examples are :—

P. 225.—Siddall, NATURE, vol. xv.—instead of *Annual Report Chester Soc. Nat. Sci.*

P. 230.—Williamson, NATURE, vol. xvii.—instead of *Proc. Manchester Lit. Phil. Soc.*

P. 250.—Suess, *Quart. Journ. Geol. Soc.*, xxvi.—instead of *Verh. k. k. geol. Reichs.*

Moreover, the hopeless nature of his published errata may indicate that the author was somewhat ashamed of his work, and it is difficult to understand why the book was not stopped and reprinted, before it was allowed to pass into circulation.

Enough has now been said of the original work—that is, the first attempted list; we will now pass on to the supplement I. In this, at least, we might have hoped that the compiler would have profited by experience, and used more care. There is certainly a difference in the proportion of typographical errors, but such details as volumes are still rather wild (*Bull. Soc. Géol. France*, for 1886, is quoted here and there as vol. x., xiv., &c.). We gather from the perusal of his supplement many things we could not understand in the original work. We recognize that the compiler is neither a born bibliographer, nor acquainted with scientific literature. We observe with satisfaction that the words "[not seen]" occur more frequently than in the earlier work, but can it be possible that the author has seen a copy of Silvestri's paper noted on p. 62? It is exceedingly rare, it does not exist in English libraries, and the writer of this has only seen two copies, both of which were sent to him from Italy. It would have been interesting to learn the pagination of so scarce a paper: the title as it at present stands is strongly suggestive of a bookseller's catalogue. And surely it was worth the compiler's while to quote Ehrenberg properly (p. 65) while the book was presumably lying open before him? The book also is known as "*Monatsbericht*" not "*Verhandlungen*," that is a secondary title. A very careless error is seen on p. 57, where *Orbitolina conoidea*, Alb., and *O. discoides*, Alb., are quoted. The original gives Albin Gras as the authority, whose paper on the subject, moreover, is well known. There should not have been confusion here. On pp. 64, 65, 71, 72, and 74, the same careless duplication of entries occurs as seen in the first attempted bibliography. But worse than all, perhaps, is the rendering of different versions of the title of one publication. A good instance of this is seen on pp. 66, 67, where six variants of *Verh. k. k. geol. Reichs.* are used, some (*Ver. K. K. Geol.*) being quite unintelligible to the uninitiated. On p. 72 we see two versions of *Ann. Soc. Belge Microsc.*, and only those familiar with the book would recognize readily "*Vierteljahrsschrift d. Zür. Natur. Gesellsch.*" (p. 74), with its chief word abbreviated. The compiler should remember that there is no necessity to quote, but, if he quotes, he should quote correctly.

It is needless to waste space on such clumsinesses as Prof. Wm. King, S.C.D. (? D.Sc.) (p. 1), or *Jahrbuch. Geol. Reicht.* It is also advisable to have some method even in printing. The compiler of this list uses roman and *italics* indiscriminately for titles of works (p. 71, Steinmann—where more prominence is thus given to the review than to the original work), while on p. 63, in the entry Alth, the word *Rozprawy* begins the title of the book, and has nothing whatever to do with the title of Dr. Alth's paper.

Many of these errors and defects might have been avoided had the compiler been accustomed to public libraries, or even endeavoured to find out the common books of reference, always at hand in these places. No bibliographer should ever think of working in scientific literature without his Carus and Englemann, his Scudder, and his Bolton, and for an American to omit to do so is sinful. No greater mistake was ever made by a writer than that made by the compiler, when he wrote in his preface that he had enjoyed facilities not enjoyed by many scientific students, those facilities afforded by the great public libraries of New York. We know what the resources of those libraries are, and the production which calls for this letter does not shake our faith in them. "Instructive" this bibliography certainly is, but not in the sense intended by its compiler.

CHAS. DAVIES SHERBORN.

Density and Specific Gravity.

MAY I ventilate a point in mechanical definition which has perplexed students within my experience—the use of the words density and specific gravity?

We are usually told that the quantity of matter in a body—as it is now called, the mass of the body—is proportional to the volume and density conjointly. This is Newton's definition of density (see also Thomson and Tait's "Natural Philosophy," § 208). Thus, if M be the mass, V the volume, and ρ the density of a body, we have—

$$M = \rho V \quad . \quad . \quad . \quad . \quad . \quad (1)$$

if the unit of mass be taken as the unit of volume of a substance of standard density.

Again, we are told that specific gravity is the ratio of the weight of the given body to the weight of an equal volume of some standard substance (Besant's "Hydrostatics and Hydrodynamics," § 13). Since weights are simply proportional to masses, it follows that the numerical values of specific gravities and densities are exactly the same. It would seem better, under these circumstances, to use one word only to express the one physical property. Accordingly, we find that specific gravity is disappearing from many of our best books (I think from Thomson and Tait's "Natural Philosophy," for example), though it still holds its place to puzzle students in examinations, and therefore teachers are compelled to make the best of it they can.

But this is not the whole evil. The definition of specific gravity is usually followed by the equation—

$$W = sV \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where W is the weight, s the specific gravity, and V the volume of the body. This equation is, no doubt, usually accompanied by the caution that the unit of weight chosen is not the unit of force proper to other dynamical equations, and for this reason the equation

$$W = \rho V g \quad . \quad . \quad . \quad . \quad . \quad (3)$$

is far to be preferred.

If equation (2) is of practical value, would it not be as well to define specific gravity in accordance with it, and say that specific gravity is the weight of unit volume of the substance? Thus, the specific gravity of water would be expressed by 62·5 lbs. avoirdupois in British units, or by 1 gramme in C.G.S. units. I believe this would have the advantage of conveying a perfectly definite idea to minds which dislike such abstractions as mass and density.

L. CUMMING.

Rugby, March 31.

"Coral Formations."

MR. MELLARD READE last week (April 5, p. 535) pointed out an error in my calculations which I had myself discovered when too late, and had intended to correct in sending you a further note on some experiments which are now in progress.

Mr. Reade seems to make use of my arithmetical blunder, and apparently attempts to discredit my experiments, and the new views as to coral-reef formations; but I leave the matter to those who have a practical knowledge of the subject.

The corals experimented upon were of the class known as hard corals, and consequently the amount dissolved must be much smaller, I imagine, than that dissolved from the softer varieties, such as Porites. The first experiment (p. 462) gives the highest result, but I have no reason to doubt that the rate of solution deduced therefrom is far below that actually taking place in the tropical areas of the Pacific and Indian Oceans.

I do not consider that Mr. Reade has given an answer to Mr. Irvine's pertinent question, though he would have it appear that an answer is patent to everyone, and he must not take up your space with such a trivial matter.

Mr. Murray, speaking of his tow-net experiments in his Royal Institution lectures, says:—"I give this calculation more to indicate a method than to give even the roughest approximation to a rate of accumulation of deposits. The experiments were too few to warrant any definite deductions"; and he is evidently satisfied that we have no knowledge, other than relative, as to the rate of accumulation of calcareous deposits.

It is at once evident to all who have used the tow-net, that Mr. Murray's experiments afford a very slender basis for calculations. Probably not more than one-fourth of the water in the track of the tow-nets actually passed through the nets, and not more than one-half of the organisms that entered them were retained; the Coccospheres, Rhabdospheres, and small Foraminifera, for instance, passing through and escaping with the

water. Then, Mr. Reade supposes all the organisms in the bulk of water taken to die and fall to the bottom each day. Mr. Murray, in his calculations, supposes only one-sixteenth part to die each day. From the same data the former makes out a rate of accumulation of deposit of 1 inch in 29 years, the latter a rate of 1 inch in 470 years. Dana estimates the growth of a reef at not greater than one-sixteenth of an inch in one year, *i.e.* 1 inch in 16 years. Yet it will be admitted that a reef must grow much more rapidly than a deep-sea deposit. What then would justify us in accepting these figures as in any way representing what is now taking place in Nature? The fact is we much want definite information on the rate of growth of these calcareous deposits, and if Mr. Reade has the information his language would warrant, he should make it known for the benefit of science.

We know that these deposits do accumulate to hundreds of feet in thickness in some places, notwithstanding solution; and it seems to me that, as we can imitate in the laboratory the conditions of solution while we cannot those of secretion by organisms, then by experiments in this direction we may at least arrive at a knowledge of the minimum rate of accumulation of oceanic calcareous deposits. JAMES G. ROSS.

14 Argyll Place, Edinburgh, April 14.

Bernicle Geese on Coniston Lake.

THIS afternoon while walking by this lake I saw four large birds flying overhead. These birds, after making several circuits in the air, pitched on the lake. I had with me an excellent pair of field-glasses, and as I succeeded in approaching within 20 yards of them, I was enabled to examine them with sufficient accuracy to convince me that they were Bernicle geese (*Anser leucopsis*, Yarrell). What struck me as most worthy of remark was their extreme tameness, as they allowed me, first on land, and then in a boat, to approach within 20 yards of them. They were in excellent plumage, and seemed in good condition. After remaining about three hours swimming about on the lake, they rose, and after circling round once or twice, flew off in a northerly direction.

May I ask if this is a rare bird to see in the Lake District at this time of year? I have inquired in the neighbourhood, and do not think they could have come from any private water. Several people who have been here for many years assure me they have never seen this bird on the lake before, and this has certainly been my own experience. Is it possible their extreme tameness was due to fatigue? WILLIAM R. MELLY.

Tent Lodge, Coniston Lake, Lancashire, April 8.

The Muzzling of Oysters.

THIS practice, described in the current number of NATURE (p. 572) as owing "its existence to a careful study of the habits of the bivalve," is by no means new, though probably original on the part of the American naturalists. Our London fishmongers have muzzled oysters on a large scale from a time that is immemorial among them. Barrelled oysters are all very carefully muzzled, but without wires, as anybody may learn by watching an expert in the process of barrelling. It will be seen that he lays the oysters one by one carefully in tiers up to the top of the barrel, and then lays another tier rising *above* the level of the top. Having done this, he places the lid of the barrel on this exuberant tier, and thumps and rattles the barrel on a stone pavement or other solid ground until, by close packing of the whole, it descends to the level of the barrel top. The mass of oysters being thus compressed so as to render the slightest gaping of any one quite impossible, he firmly nails down the head of the barrel.

Experience has proved that oysters thus effectively muzzled may take long slow journeys (as they did in the old coaching days) and be kept fresh and without loss of flavour for two or three weeks, provided the barrels are unopened. If, however, they are loosely barrelled, a few days are too many. In some old country houses the barrels, unopened, were placed in salt water, and thus kept until required, but whether this was advantageous I cannot say.

W. MATTIEU WILLIAMS.

The Grange, Neasden, April 13.

SUGGESTIONS ON THE CLASSIFICATION OF THE VARIOUS SPECIES OF HEAVENLY BODIES.[1]

I.

I.—PROBABLE ORIGIN OF SOME OF THE GROUPS.

I. NEBULÆ.

IN a paper communicated to the Royal Society on November 15, 1887, I showed that the nebulæ are composed of sparse meteorites, the collisions of which bring about a rise of temperature sufficient to render luminous one of their chief constituents—magnesium. This conclusion was arrived at from the facts that the chief nebula lines are coincident in position with the fluting and lines visible in the bunsen burner when magnesium is introduced, and that the fluting is far brighter at that temperature than almost any other spectral line or fluting of any element whatever.

I suggested that the association or non-association of hydrogen lines with the lines due to the olivine constituents of the meteorites might be an indication of the greater or less sparseness of the swarm, the greatest sparseness being the condition defining fewest collisions, and therefore one least likely to show hydrogen. This suggestion was made because observations of comets and laboratory work have abundantly shown that great liability to collision in the one case, and increase of temperature in the other, are accompanied by the appearance of the carbon spectrum instead of the hydrogen spectrum.

The now demonstrated meteoric origin of these celestial bodies renders it needful to discuss the question in somewhat greater detail, with a view to classification; and to do this thoroughly it is requisite that we should study the rich store of facts which chiefly Sir William Herschel's labours have placed before us regarding the various forms of nebulæ, with the view of ascertaining what light, if any, the new view throws on their development.

To do this the treatment must be vastly different from that—the only one we can pursue—utilized in the case of the stars, the images of all, or nearly all, of which appear to us as points of light more or less minute, while, in the case of the nebulæ, forms of the most definite and, in many cases, of the most fantastic kind, have been long recognized as among their chief characteristics.

It will at once be evident that since the luminosity of the meteorites depends upon collisions, the light from them, and from the glow of the gases produced from them, can only come from those parts of a meteor-swarm in which collisions are going on. Visibility is not the only criterion of the existence of matter in space; dark bodies may exist in all parts of space, but visibility in any part of the heavens means, not only matter, but collisions, or the radiation of a mass of vapour produced at some time or other by collisions. The appearances which these bodies present to us may bear little relation to their actual form, but may represent merely surfaces, or loci of disturbances.

It seemed proper, then, that I should seek to determine whether the view I have put forward explains the phenomena as satisfactorily as they have been explained on the old ones, and whether, indeed, it can go further and make some points clear which before were dark.

To do this it is not necessary in the present paper to dwell at any great length either on those appearances which were termed *nebulosities* by Sir William Herschel or on irregular nebulæ generally; but it must be remarked that the very great extension of the former—which there is little reason to doubt will be vastly increased by increase of optical power and improvement in observing conditions and stations—may be held to strengthen the view that space is really a meteoritic plenum, while the forms indicate motions and crossings and interpenetra-

[1] The Bakerian Lecture, delivered at the Royal Society on April 12, by J. Norman Lockyer, F.R.S.

tions of streams or sheets, the brighter portions being due to a greater number of collisions per unit volume.

When we come to the more regular forms we find that they may be generalized into three groups, according as the formative action seems working towards a centre, round a centre in a plane, or nearly so, or in one direction only; as a result we have globular, spheroidal, and cometic nebulæ. I propose to deal with each in turn.

Globular Nebulæ.

The remarkable appearance presented by the so-called planetary nebulæ requires that I should refer to them in some detail. Sir William Herschel does not describe them at any great length, but in his paper on "Nebulous Stars" he alludes to the planetary nebulosity which in many cases is accompanied by a star in the centre, and finally comes to the conclusion that "the nebulosity about the star is not of a starry nature" (Phil. Trans., vol. lxxxi. p. 73, 1791).

Sir John Herschel, in his valuable memoir published in Phil. Trans., 1833, describes them as "hollow shells" (p. 500). It was so difficult to explain anything like their appearance by ordinary ideas of stellar condensation that Arago, as quoted by Nichol ("Architecture of the Heavens," p. 86), abandoning altogether the idea that they represented clusters of stars or partook in any wise of a stellar constitution, imagined them as hollow spherical envelopes, in substance cloudy and opaque, or rather semi-transparent; a brilliant body invisible in the centre illuminating this spherical film, so that it was made visible by virtue of light coming through it and scattered by reflection from its atoms or molecules. The mystery was explained to a certain extent by Lord Rosse, who (Phil. Trans., 1850, vol. cxl. p. 507) states that nearly all the planetary nebulæ which he had observed with his colossal instruments up to that time had been found to be perforated. In only one case was a perforation not detected, but in this ansæ were observed, introducing into the subject for the first time the idea of nebulous bodies resembling to a certain extent the planet Saturn. But Lord Rosse, although he thus disposed of the idea of Arago, still considered that the annular nebulæ were really hollow shells, the perforation indicating an apparently transparent centre.

Huggins and Miller subsequently suggested that the phenomena represented by the planetary nebulæ might

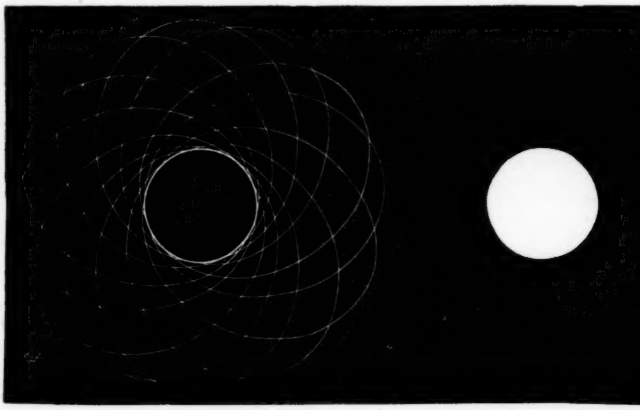


FIG. 1.—Suggested origin of the appearance presented by a planetary nebula. The luminosity is due to the collisions occurring along the sphere of intersection of the elliptic orbits of the meteorites. The left-hand diagram is a cross-section of the meteoric system, and the right-hand one shows the appearance of the collision shell as seen from a point outside.

be explained without reference to the supposition of a shell (or of a flat disk) if we consider them to be masses of glowing gas, the whole mass of the gas being incandescent, so that only a luminous surface would be visible (Phil. Trans., vol. cliv. p. 442, 1864).

It will be seen that all these hypotheses are mutually destructive; but it is right that I should state, in referring to the last one, that the demonstration that these bodies are not masses of glowing gas merely has been rendered possible by observations of spectra which were not available to Messrs. Huggins and Miller when their important discovery of the bright-line spectrum of nebulæ was given to the world.

It remains, then, to see whether the meteoritic hypothesis can explain these appearances when it is acknowledged that all the prior ones have broken down. Let us for the sake of the greatest simplicity consider a swarm of meteorites at rest, and then assume that others from without approach it from all directions, their previous paths being deflected. There will be at some distance from the centre of the swarm a region in which collisions will be most valid. Meteorites arrested here will begin to move in almost circular orbits round the common centre of gravity.

The major axes of these orbits may be assumed to be not very diverse, and we may further assume that, to begin with, one set will preponderate over the rest. Their elliptic paths may throw the periastron passage to a considerable distance from the common centre of gravity; and if we assume that the meteorites with this common mean distance are moving in all planes, and that some are direct and some retrograde, there will be a shell in which more collisions will take place than elsewhere. *Now, this collision surface will be practically the only thing visible, and will present to us the exact and hitherto unexplained appearance of a planetary nebula—a body of the same intensity of luminosity at its edge and centre—thus putting on an almost phosphorescent appearance.*

Such a collision surface, as I use the term, is presented to us during a meteoric display by the upper part of our atmosphere.

I append a diagram, Fig. 1, which shows how, if we thus assume movement round a common centre of gravity in a mass of meteorites, one of the conditions of movement being that the periastron distance shall be somewhat considerable, the mechanism which produces the appearance of a planetary nebula is at once made

apparent. The diagram shows the appearance on the supposition that the conditions of all the orbits with reference to the major axis shall be nearly identical, but the appearances would not be very greatly altered if we take the more probable case in which there will be plus and minus values.

Globular Nebulæ showing Condensations until finally a Nebulous Star is reached.

If we grant the initial condition of the formation of a collision-shell, we can not only explain the appearances put on by planetary nebulæ, but a continuation of the same line of thought readily explains those various other classes to which Herschel has referred, in which condensations are brought about, either by a gradual condensation towards the centre, or by what may be termed successive jumps, showing that they are among the earliest stages of nebular development.

To explain these forms we have only to consider what will happen to the meteorites which undergo collision in the first shell. They will necessarily start in new orbits,

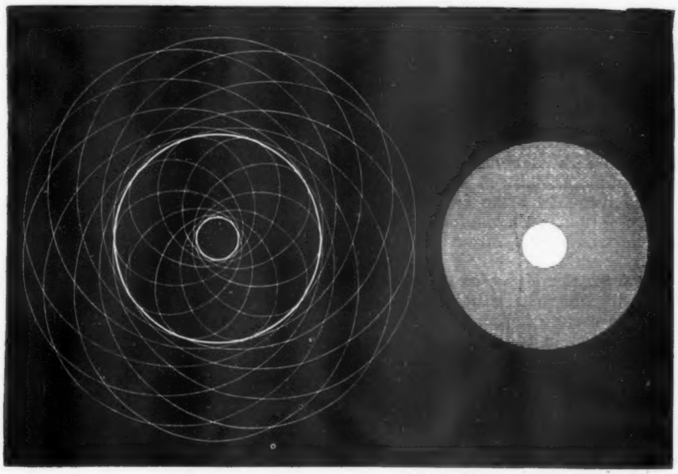


FIG. 2.—Suggestion as to the origin of a globular nebula with a brighter central portion. As in the former case, the luminosity of the fainter portion is due to the collisions which occur along the sphere of intersection represented by the larger circle. After collision the meteorites will travel in new orbits, and there will be an additional sphere of intersection, represented by the smaller circle. The left-hand diagram is a cross-section, and the right-hand one represents the appearance of the two collision shells as seen from a point outside.

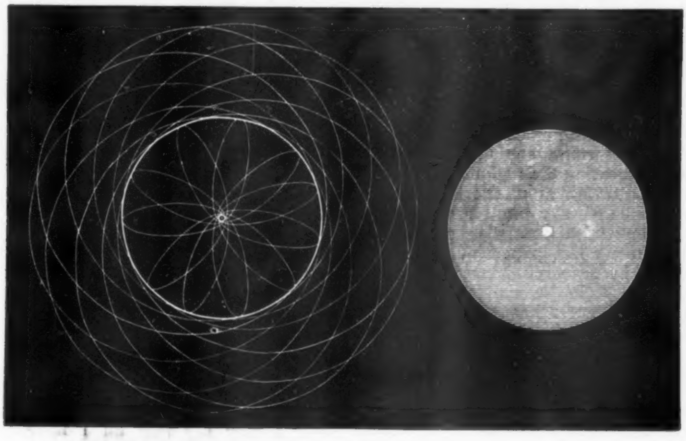


FIG. 3.—Suggestion as to the origin of a nebulous star. The orbits of the inner set of meteorites are very elliptic, so that the shell of intersection appears almost as a point. As in the previous cases, the left-hand diagram represents the meteoric systems in section, and the right-hand one the appearance from a point outside.

and it is suggested that an interior collision-shell will in this way be formed.

In consequence of the collisions the orbits will have a tendency to get more and more elliptic, while the pericentric distance will at the same time be reduced; the swarm will, in consequence of this action, gradually brighten towards the centre through collisions being possible nearer the centre, and ultimately we shall have nebulæ with a distinct nucleus, the nucleus then representing the *locus* of most collisions. This brightness may be sudden in places, or quite gradual, according to the collision conditions in each swarm. The final stage will be a nebulous star.

Effects of Subsequent Rotation.—Spheroidal Nebulæ.

In such meteor-swarms as those we have considered, it must be that rotation is sooner or later set up. Otherwise it would be impossible to account for the spheroida

nebulæ at all. I am aware that in Newton's opinion the cause of this rotation was not mechanical, but the moment we assume a meteoric origin of these globular clusters it is straining the facts to assume that the in-take will be exactly the same at all points, and the moment the bombardment is more or less localized, rotation must follow sooner or later. Sir William Herschel, in his paper of 1811 (p. 319), says: "If we consider this matter in a general light, it appears that every figure which is not already globular must have eccentric nebulous matter, which, in its endeavour to come to the centre, will either dislodge some nebulosity which is already deposited, or slide upon it sideways, and in both cases produce a circular motion; so that, in fact, we can hardly suppose a possible production of a globular form without a subsequent revolution of nebulous matter, which in the end may settle in a regular rotation about some fixed axis."

Given, then, a globular swarm with a rotation around an axis, we have to discuss the phenomena produced by collisions under a new set of circumstances.

Here at once we have to account for the fact that the nearly spherical forms are very short-lived, for they are very rare; we seem to jump, as it were, from globes to very extended spheroids.

If it be conceded that from the above considerations we are justified in supposing that the elliptic and other spheroidal nebulæ really represent a higher stage of evolution than those presented to us in the globular form, it is clear that on the meteoritic hypothesis the greater part of the phenomena will represent to us what happens to such a system under the condition of a continuous bombardment of meteorites from without.

So soon as we have a minor axis, there will at first be more collisions parallel to it; the result of this will be that the equatorial plane will be intensified, and then, later on, if we conceive the system as a very extended spheroid, it is obvious that meteorites approaching it in directions parallel to its minor axis will now have fewer chances of collisions than those which approach it, from whatever azimuth, in what we may term the equatorial plane. These evidently, at all events if they enter the system in any quantity, will do for the equatorial plane exactly what their fellows were supposed to do for the section in Fig. 1, and we shall have on the general background of the symmetrically rotating nebula, which may almost be invisible in consequence of its constituent meteorites all travelling the same way and with nearly equal velocities, curves indicating the regions along which the entrance of the new swarm is interfering with the movements of the old one; if they enter in excess from any direction, we shall have broken rings or spirals.

This was suggested in my last paper. Various rings will indicate the regions where most collisions are possible, and the absence of luminosity in the centre by no means demonstrates the absence of meteorites there.

Researches by Lord Rosse and others have given us forms of nebulæ which may be termed sigmoid and Saturnine, and these suggest that they and the elliptical nebulæ themselves are really produced by the rotation of what was at first a globular rotating swarm of meteorites, and that in these later revelations we pick up those forms which are produced by the continued flattening of the sphere into a spheroid under the meteoric conditions stated. It is worthy of remark that all the forms taken on by the so-called elliptic nebulæ described by the two Herschels, and by the spiral, sigmoid, and Saturnine forms which have been added to them by the labours of Lord Rosse and others, are recalled in the most striking manner by the ball of oil in Plateau's experiment, when rotations of different velocities are imparted to it. It is my intention to repeat Plateau's experiments, and to take instantaneous photographs of the various phenomena presented, and to place them side by side with the drawings of nebulæ, of which they are almost the exact counterparts.

The Saturnine form may, indeed, in some cases represent either the first or last stages in this period of the evolutionary process. I say *may* represent, in consequence of the extreme difficulty in making the observations, so that in the early stages a spherical nebula, beginning to change into a spheroid, may have its real spheroidal figure cloaked by various conditions of illumination.

The true Saturnine form must, as in the case of Saturn itself, represent one of the latest forms in the meteor-swarm, because, if it be not continually fed from without, collisions must sooner or later bring all the members of the swarm to the centre of figure.

Cometic Nebulæ.

I do not know that any explanation has, so far, been suggested as to the origin of these curious forms, which were first figured by Sir William Herschel, and of which a number have recently been observed in the southern hemisphere ("Melbourne Observations"). It is clear that in them the conditions are widely different from those hitherto considered in this paper. I think that the meteoritic hypothesis satisfactorily explains them, on the supposition that we have either a very condensed swarm moving at a very high velocity through a sheet of meteorites at rest, or the swarm at rest surrounded by a sheet all moving in the same direction. It is a question of relative velocity.

If we consider the former case, it is clear that the collision region will be in the rear of the swarm, that the collision will be due to the convergence of the members of the sheet due to the gravity of the swarm, and that the collision region will spread out like a fan behind the swarm.

The angle of the fan, and the distance to which the collisions are valid, will depend upon the velocity of the condensed swarm.

Nebulous Origin of some Bodies which appear as Stars.

From this point of view it is also possible that many stars, instead of being true condensed swarms due to the nebulous development to which we have referred, are simply appearances produced by the intersection of streams of meteorites. They are, then, simply produced by an intensification of the conditions which gave rise to the brighter appearances recorded by Herschel here and there in his diffused nebulosities. The nebulous appendages sometimes seen in connection with stars strengthen this view.

II. Stars with Bright Lines or Flutings.

I pointed out in my last paper that those stars in the spectra of which bright lines had been observed were in all probability the first result of nebulous condensation, both their continuous spectrum and that of the surrounding vapour being produced by a slightly higher temperature than that observed in nebulæ in which similar though not identical phenomena are observed.

I have recently continued my inquiries on this point: and I may say that all I have recently learned has confirmed the conclusions I drew in my last paper, while many of the difficulties have disappeared. Before I refer to these inquiries, however, it is necessary to clear the ground by referring to the old view regarding the origin of bright lines in stellar spectra, and to the question of hydrogen.

Reference to the Old View by which it was supposed some of the Bright-line Phenomena might be accounted for.

In the views which, some years ago, were advanced by myself and others, to account for the bright lines seen

in some of the "stars" to which reference has been made, the analogy on which they were based was founded on solar phenomena; the "stars" in question being supposed to be represented in structure by our central luminary. The main constituent of the solar atmosphere outside the photosphere is hydrogen, and it was precisely this substance which was chiefly revealed by these stellar observations and in the Novas, in which cases it was sometimes predominant. A tremendous development of an atmosphere like that of the sun seemed to supply the explanation of the phenomena.

Acting on this view in 1878,[1] I attempted to catch these chromospheric lines in α Lyræ, abandoning the use of a cylindrical lens in front of the slit with this object in view.

Further, it was quite clear that if such gigantic supra-photospheric atmospheres existed, their bright lines might much modify their real absorption-spectra; even "worlds without hydrogen" might be thus explained without supposing a *lusus naturæ*, and so I explained them.

That this view is untenable, as I now believe, and that it is unnecessary, will, I think, be seen from what follows. A long series of newly described phenomena, which are absolutely incomprehensible while it is applied to them, find, I think, a simple and sufficient explanation. I must hold that the view is untenable, because how a body constituted in any way like the sun could change its magnitude from the thirteenth to the sixth every year or so, or change its hydrogen lines from bright to dark once a week, passes comprehension; and the more closely a "star" resembles the sun the less likely are such changes to happen. Even the minor evolutionary changes are inexplicable on this hypothesis, chiefly because in a completely condensed mass the temperature must be very high and constant, while I have shown that the spectrocopic phenomena are those of a specially low temperature; and I may now add that many of the objects are extremely variable in the quantity and quality of the light they emit.

Another cause of the appearance of the hydrogen lines has been suggested by Mr. Johnstone Stoney (Proc. Roy. Soc., vol. xvii. p. 54). He considers it due to the clashing together of the atmospheres of two stars, the outer constituent of the atmosphere—hydrogen—alone being raised by the friction to brilliant incandescence.

Another objection we can urge against the old view is that all bodies in the universe cannot be finished suns in the ordinary sense, and that it leaves out of account all possible processes of manufacture, not only of single stars, but of double and multiple systems, at all stages between nebula and sun; while the new one, by simply changing the unit from the star to each individual constituent, it is hardly too much to say, explains everything, though it is perfectly true that in some of the steps a considerable acquaintance with spectroscopic phenomena is necessary to realize the beauty and the stringency of the solutions.

[1] ". . . The sun which we see, the sun which sends us the majority of the light we receive, is but a small kernel in a gigantic nut, so that the diameter of the real sun may be, say, two million miles. Suppose then that some stars have very large coronal atmospheres; if the area of the coronal atmosphere is small compared with the area of the section of the true disk of the sun, of course we shall get an ordinary spectrum of the star; that is to say, we shall get the indications of absorption which make us class the stars apart; we shall get a continuous spectrum barred by dark lines. But suppose that the area of the coronal atmosphere is something very considerable indeed, let us assume that it has an area, say fifty times greater than the section of the kernel of the star itself; now, although each unit of surface of that coronal atmosphere may be much less luminous than an equal unit of surface of the true star at the centre, yet, if the area be very large, the spectroscopic writing of that large area will become visible side by side with the dark lines due to the brilliant region in the centre where we can study absorption; other lines (bright ones) proceeding from the exterior portion of that star will be visible in the spectrum of the apparent *point* we call a star. Now it is difficult to say whether such a body as that is a star or a nebula. We may look upon it as a nebula in a certain stage of condensation; we may look upon it as a star at a certain stage of growth."—Proc. R.S. 1878, No. 185, p. 49.

The Question of Hydrogen in the Case of Bright-Line Stars.

It may be convenient also that I should summarize the various conditions under which the lines of hydrogen are observed in the meteorite swarms we are now considering.

In the "nebulæ" we begin with the widest interspaces. Future investigation may show that, as I have suggested, those in which the hydrogen lines are absent are the most widely spaced of all. Be this as it may, it is a matter of common knowledge that with the brighter nebulæ, such as that of Orion, to take an instance, we have hydrogen associated with the low-temperature radiation of olivine. That the hydrogen is electrically excited to produce this glow is proved by the fact that the temperature of the meteorites themselves must be very low; otherwise the magnesium would not show itself without the manganese and iron constituents, and the continuous spectrum would be much brighter and longer than it is.

In the former paper I showed that in my laboratory experiments, when the pressure was slightly increased in a tube containing gases obtained from meteorites, the carbon bands began to be visible. We should expect this to happen therefore in a meteor swarm at some point at which the mean interstitial space was smaller than that accompanied by the appearance of the hydrogen lines; and it would be natural that both should be seen together at an early stage and both feeble, by which I mean not strongly developed, as hydrogen is not strongly developed even in the nebula of Orion, none of the ultra-violet lines being visible in a photograph, while the magnesium line is.

The association of the low-temperature lines of hydrogen with the flutings of carbon is therefore to be expected, and I shall subsequently show that we have such an association in the so-called bright-line stars; and even at a further stage of development, in stars like α Orionis, the hydrogen is still associated with the carbon.

The Cometic Nature of Stars with Bright Lines in their Spectra.

Seeing that the hypothesis I am working on demands that the luminosity in stars and the bright lines in their spectra are produced by the collisions of meteorites, the spectra of those bodies must in part resemble those of comets, in which bodies by common consent the luminosity is now acknowledged to be produced by collisions of meteorites.

We must, however, first consider the vast difference in the way in which the phenomena of distant and near meteoric groups are necessarily presented to us; and, further, we must bear in mind that in the case of comets, however it may arise, there is an action which drives the vapours produced by impacts outward from the swarm in a direction opposite to that of the sun.

It must be a very small comet which, when examined spectroscopically in the usual manner, does not in consequence of the size of the image on the slit enable us to differentiate between the spectra of the nucleus and envelopes. The spectrum of the latter is usually so obvious, and the importance of observing it so great, that the details of the continuous spectrum of the nucleus, however bright it may be, are almost overlooked.

A moment's consideration, however, will show that if the same comet were so far away that its whole image would be reduced to a point on the slit-plate of the instrument, the differentiation of the spectra would be lost; we should have an integrated spectrum in which the brightest edges of the carbon bands, or some of them, would or would not be seen superposed on a continuous spectrum.

The conditions of observations of comets and stars being so different, any comparison is really very difficult; but the best way of proceeding is to begin with the spectrum of comets in which, in most cases, for the reason given, the phenomena are much more easily and accurately recorded.

But even in the nucleus of a comet as in a star it is much more easy to be certain of the existence of bright lines than to record their exact positions,[1] and as a matter of fact bright lines have been recorded, notably in Comet Wells and in the great comet of 1882.

The main conclusion to which my researches have led me is that the stars now under consideration are almost identical in constitution with comets between that condition in which, as in those of 1866 and 1867, they give us the absolute spectrum of a nebula and that put on by the great comet of 1882.

I am aware that this conclusion is a startling one, but a little consideration will show its high probability, and a summary of all the facts proves it, I think, beyond all question.

While we have bright lines in comets, it can be shown that some of them are the remnants of flutings. Thus in Comet III. of 1881, as the carbon lines died away the chief manganese fluting at 558 became conspicuously visible; it had really been recorded before then. The individual observations are being mapped in order that the exact facts may be shown. It may probably be asked how it happened that the fluting of magnesium at 500 was not also visible. Its absence, however, can be accounted for: it was *masked* by the brightest carbon fluting at 517, whereas the carbon fluting which under other circumstances might mask the manganese fluting at 558 is always among the last to appear very bright and the first to disappear.

In the great comet of 1882, which was most carefully mapped by Copeland, very many lines were seen, and indeed many were recorded, and it looks as if a complete study of this map will put us in possession of many of the lines recorded by Sherman in the spectrum of γ Cassiopeiæ. We have then three marked species of non-revolving swarms going on all fours with three marked species of revolving ones, and in this we have an additional argument for the fact that the absence in the former of certain flutings which we should expect to find may have their absence attributed to masking by the carbon flutings.

We have next, then, to show that there are carbon bands in the bright-line stars.

There is evidence of this. Among the bright lines recorded is the brightest carbon fluting at 517. This is associated with those lines of magnesium and manganese and iron visible at a low temperature which have been seen in comets.

But we have still more evidence of the existence of carbon. In a whole group of bright-line stars there is a bright band recorded at about 470, while, less refrangible than it, there appears a broad absorption band. I regard it as extremely probable that we have here the bright carbon band 467–474, and that the appearance of an absorption band is due to the fact that the continuous spectrum of the meteorites extends only a short distance into the blue.

If we consider such a body as Wells's comet, or the great comet of 1882, as so great a distance from us that only an integrated spectrum would reach us, in these cases the spectrum would appear to extend very far, and more or less continuously, into the blue; but this appearance would be brought about, not by the continuous spectra of the meteorites themselves, but by the addition of the hydrocarbon fluting at 431 to the other hot and cold carbon bands in that part of the spectrum.

There are other grounds which may be brought forward to demonstrate that the difference between comets and the stars now under discussion is more instrumental than physical.

Supposing that the cometic nature of these bodies be conceded, the laboratory work will show us which flutings and lines will be added to the nebula spectrum upon each rise of temperature; and the discussion, so far as it has gone, seems to show that such lines and flutings have actually been observed.

The difficulties of the stellar observations must always be borne in mind. It will also be abundantly clear that a bright fluting added to a continuous spectrum may produce the idea of a bright line at the sharpest edge to one observer, while to another the same edge will appear to be preceded by an absorption band.

III. Stars with Bright Flutings accompanied by Dark Flutings.

I also showed in the paper to which reference has been made that the so-called "stars" of Class III.*a* of Vogel's classification are not masses of vapour like our sun, but really swarms of meteorites; the spectrum being a compound one, due to the radiation of vapour in the interspaces and the absorption of the light of the red- or white-hot meteorites by vapours volatilized out of them by the heat produced by collisions. The radiation is that of carbon vapour, and some of the absorption, I stated, was produced by the chief flutings of manganese.

These conclusions were arrived at by comparing the wave-lengths of the details of spectra recorded in my former paper with those of the bands given by Dunér in his admirable observations on these bodies.[1]

The discovery of the cometic nature of the bright-line stars greatly strengthens the view I then put forward, not only with regard to the presence of the bright flutings of carbon, but with regard to the actual chemical substances driven into vapour. From the planetary nebulæ there is an undoubted orderly sequence of phenomena through the bright-line stars to those now under consideration, if successive stages of condensation are conceded.

I shall return to these bodies at a later part of this memoir.

IV. Stars in which Absorption Phenomena predominate.

I do not suppose that there will be any difficulty in recognizing, that if the nebulæ, stars with bright lines, and stars of the present Class III.*a* are constituted as I state them, all the bodies more closely resembling the sun in structure, as well as those more cooled down, must find places on a temperature curve pretty much as I have placed them; the origin of these groups being, first still further condensation, then the condition of maximum temperature, and then the formation of a photosphere and crust.

We shall be in a better position to discuss these later stages when the classifications hitherto adopted have been considered.

(*To be continued.*)

THE HITTITES, WITH SPECIAL REFERENCE TO VERY RECENT DISCOVERIES.[2]

IV.

THOSE who have attempted to decipher the Hittite inscriptions have not always regarded a fact which may be discerned with tolerable facility. The inscriptions from Hamath, and those from Jerablûs or Carchemish, though no doubt deriving their origin from a common source, yet present, as we know them, two distinct types. Symbols usual and frequently repeated on the Jerablûs monuments are wholly absent from those of

[1] "*Observations of Comet III.*, 1881, *June* 25.—The spectrum of the nucleus is continuous; that of the coma shows the usual bands. With a narrow slit there are indications of many lines just beyond the verge of distinct visibility."—Copeland, *Copernicus*, vol. ii. p. 226.

[1] "Les Étoiles à spectres de la troisième classe," *Kongl. Svenska Vitenskaps-Akademiens Handlingar*, Bandet 21, No. 2, 1885.

[2] Based on Lectures delivered by Mr. Thomas Tyler at the British Museum in January 1883. Continued from p. 562.

Hamath. Other symbols, not difficult to identify as essentially the same, yet assume a form more or less changed. The difference is altogether so considerable that in ancient times the ability to read and fully understand the one type may quite possibly not have involved a facility of perfectly comprehending the other. The difference might be spoken of as one of *dialect*, if that word could be, in this case, appropriately employed. Then, so far as the more considerable monuments in the Museum from Jerablûs or Carchemish are concerned, there is clearly between them a difference in age, and the difference may possibly be very great. As evidence in support of this assertion, I may adduce a symbol which was intended apparently to denote an agricultural implement. When this symbol was given as in Fig. M (1), though probably drawn out of perspective and perhaps already somewhat conventionalized, yet its relation to the actual object would seem to have been not very distant. But when the symbol has become changed in the manner that appears

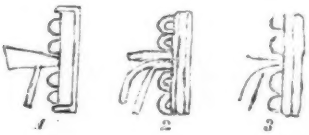


FIG. M.—Symbols of agricultural implements: 1 and 2, from Jerablûs monuments; 3, from incised bowl.

in (2), there is no difficulty in recognizing that a considerable interval must have elapsed. In (3), on an incised bowl, at present deposited in the British Museum, the same symbol has assumed something of a hieratic form. Though the bowl was found at the site of Babylon, the inscription cut into it obviously belongs to the Carchemish type. Possibly the bowl had been brought from Carchemish as a trophy.

It is conceivable that (1) might denote a kind of harrow, but more probably the vertical portion represents the end of a threshing-sledge, with teeth of stone or iron projecting therefrom. It appears to me very doubtful whether this symbol (which is not found on the inscriptions from Hamath) is ever used with any direct reference to agricultural operations. It is rather to be understood figuratively of severity in warfare and of the devastation of an enemy's country. This is in accordance with the usage of the Biblical books, which, on account of local contiguity, have, in relation to the Hittite inscriptions, peculiar importance. Thus we find, in Amos i. 3, "For three transgressions of Damascus, and for four, I will not turn away [the punishment] thereof; because they have threshed Gilead with threshing-instruments of iron"; and there are other similar passages. Moreover, such metaphorical or figurative employment of material symbols is in accordance with what we know of the use of picture-writing by the American Indians. I ought, perhaps, to add that on the Carchemish inscriptions the threshing-sledge is usually accompanied by what is probably the representation of the more essential parts of a plough somewhat conventionalized. Between the pole (or handle) and the

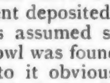


FIG. N.—Probable symbol of plough.

share or tooth, wedges would seem to have been inserted to keep the tooth firm in its place. By an easy metonymy a plough would denote land tilled and cultivated. Fig. N gives this symbol as accompanying Fig. M (2).

The difficulty of explaining the characters of the Hittite inscriptions may result in part from the objects originally depicted being such as are no longer known to us. But probably a much more serious cause of difficulty is to be found in conventionalization and the changes made to facilitate rapid execution. And we must take into account, in addition, the necessity which would arise in some cases for the lateral compression of the representation, if I may so speak, in order that the symbol might be conveniently given in the same line and in association with other symbols. This last remark applies particularly to a symbol which, there is strong reason to believe, represents the *shadoof*, or instrument for raising water, still used in the East. It would have been inconvenient to represent at full length the lever at top, with a weight at one end, and a bucket, suspended by a cord or

FIG. O.—*Shadoof* symbol, from Jerablûs inscriptions.

chain, from the other. Consequently we have the instrument represented with modification, and with the lever shortened. Here again in all probability the symbol is used for the most part figuratively, and not in general with reference to the raising of water or the irrigation of land. People familiar with the swinging up and down of the lever, and of bringing up the bucket of water, might use the symbol of "raising" in a wider sense, or generally of active and efficient operation. It is probably with this latter meaning that it is employed in three out of the five Hamath inscriptions, and in a combination of symbols which is exceedingly interesting and instructive. Two of the three are represented in Fig. P. As to the general subject, the presence of the hand grasping warlike weapons can scarcely leave a doubt; and in accordance with this indication is the spear-head, however ornamented, at the other end of the figure. The two triangular-topped symbols between, probably denote actual conflict. The idea represented conventionally

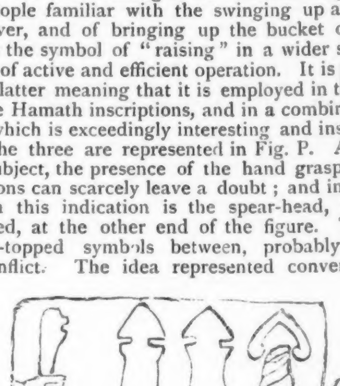


FIG. P.—Groups of symbols ending two Hamath inscriptions.

may be that of a mass of warriors who have closed together in deadly combat, or a mass of spears seen together. Under the first of these triangular-topped figures is a symbol which has been supposed to represent an insect. The two symbols together may be taken as meaning "war commencing." In the second place, we have a combination with the *shadoof*, and we may interpret,

"war in active operation." In the third combination the change in both the symbols is to be noted. That at the top may refer to a custom of enwreathing or adorning the arms of warriors to denote success in war, and to celebrate victory; and the change in the *shadoof* corresponds therewith. In (1) the vertical bar is doubled, and two short horizontal bars are added beneath; in (2) we may take it that the same end is attained by lengthening the vertical bar, while, as before, the two short horizontal bars are added, and the ornamentation of the spear is lengthened. This third combination manifestly marks the climax; but it can only indicate this, if, in accordance with what I have already said, the inscriptions are to be read "with the faces." And very important additional evidence is also furnished by these groups as to the ideographic character of the inscriptions.

That a comparatively primitive people, employing the *shadoof*, the plough, and the threshing-sledge, should use figures of these instruments to represent ideas more or less abstract can scarcely excite surprise. Probably, too, a paucity of symbols might lead to those employed being used to denote a plurality of somewhat diverse significations.

A symbol, with regard to the meaning of which the evidence is especially clear, is the symbol of deity or divinity on the Jerablûs monuments. This symbol consists of a straight stroke and a crescent, denoting in all probability Asherah, "the straight," and the goddess

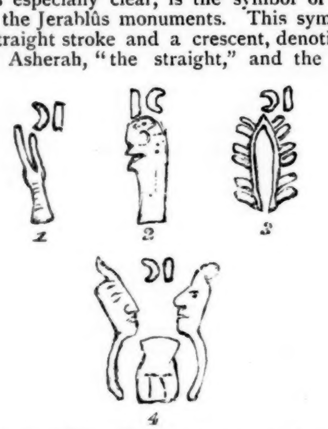


FIG. Q.—The symbol of deity, with various figures on Jerablûs monuments.

Ashtoreth. Such a combination would accord with the close relation between Asherah and Ashtoreth in the Old Testament.[1] But, whether this explanation is admitted or not, that the symbol denotes deity or sacredness can scarcely admit of question. In the first place the symbol occurs invariably *at the top of the line* on the Jerablûs monuments. This fact is itself significant. Then, three times on the "doorway inscription" what are evidently hands, though somewhat conventionalized, are held up towards the symbol in worship, as with the palm upward (1), according to the widely-spread custom, and also, as it would seem, in giving thanks (Fig. T). The symbol is to be seen also above a sacred tree (3), and above a rudely-shaped idol (2), from a fragment found at Jerablûs. This idol may have been a *lusus naturæ*, presenting a distant resemblance to the human face, and but slightly modified by art. And on the rounded pillar from Jerablûs, which bears the most modern, comparatively, of the three considerable inscriptions obtained from this site, we find the same symbol over very curious figures which, as it seems to me, were intended to represent spiritual beings or disembodied souls (4). They are insubstantial εἴδωλα, mere masks as it would appear, and with tail-like prolongations instead of bodies. They are horned, however, and the horn was a sign of dignity and power. On the whole, the evidence of the value of the straight stroke and crescent is, in my judgment, entirely conclusive. I ought to add that this symbol is not found on the inscriptions from Hamath; and thus in all probability is indicated a difference of religious cult.[1]

An interesting question presents itself as to whether the names of Hamath and Carchemish can be detected on the inscriptions. In reply it may be stated that the name or symbol of the ancient city on the site of Jerablûs may be pointed out with a good deal of confidence.

FIG. R.—Name of ancient city on Jerablûs monument.

The oval symbol, which appears at the top in Fig. R, in its origin was intended, no doubt, as a plan of a city. A similar oval form, both of the military camp and of the city (Layard's "Monuments of Nineveh," pl. 77), is to be seen depicted on the Assyrian monuments. And, with regard to the Hittite symbol, it is also worthy of note that not only on the Egyptian monuments is there an analogous circular symbol of "city" or "place," but that a similar symbol, with the like meaning, was found in Mexico, both of circular form, and, as it would seem, also oval. For the latter see Brasseur de Bourgbourg, "Études sur le Système graphique et la Langue des Mayas," Paris, 1869, vol. i. p. 150. From the Assyrian monuments it appears that fortresses were not uncommonly of angular and quadrilateral form. I therefore take the lozenge-shaped figure to denote the idea of "fortress." Like the "city" symbol it has what we may regard as a road or street crossing it; and it has markings indicating, in all probability, gates, at the other corners. Then, as to the eagle, a question of great interest, if of some difficulty, presents itself. The ancient city on the site of Jerablûs we have identified with Carchemish. As already stated, the name Carchemish has been looked upon as denoting "the fortress of Chemosh." The question then occurs, If the lozenge-shaped figure denotes "fortress," does the eagle denote Chemosh? Whatever may be the etymology of "Chemosh," it is sufficiently probable that Chemosh was, like Baal and Moloch, a solar deity. This, indeed, has been previously suggested. And the sun might very well be represented by the eagle, the bird of the sun. Moreover such a view is not purely hypothetical. As is well known, in ancient Egypt, Horus, the god of the rising sun, was represented by the hawk. Then there is reason to think that, in connection with the solar cult, the eagle was worshipped or regarded as a sacred bird at places in or near the Hittite country, and not very far distant from Carchemish.

Looking, then, upon the eagle and upon the second part of the name "Car-chemish" as both representing Chemosh, there remains no difficulty about the first part of the name, as we find, in Assyrian, *caru*, a fortress—a word found also, with comparatively slight modification, in Hebrew (*kir*).

[1] Asherah was probably a phallic symbol. This accords with the view of Movers ("Die Phönizier," vol. i. p. 560 *sqq.*), and with that of the Rabbins (cf. I. Kings xv. 13, and the commentaries thereon).

[1] There is another sign, **IL**, which, though less frequent, yet appears as if a variant of the sign of deity usual in inscriptions of the Jerablûs type. This sign somewhat puzzled me till, on the coinage of Mallus, in Cilicia, I found the right angle together with the straight stroke, or *asherah*, the equilateral triangle, and the cone. All these were, no doubt, connected with the goddess Astarte, to whose service Mallus seems to have been especially devoted. It is, in all probability, this deity who appears in winged form on the obverse of the coin, which Mr. Barclay V. Head, the eminent numismatist, assigns to a date earlier than 400 B.C. I ought to add that the sign with the right angle, which probably denotes a different aspect or function of the goddess, occurs apparently in the Hamath inscriptions

With regard to Hamath, though the evidence is weaker, yet probably the city is indicated by a symbol consisting of the vase or receptacle (Fig. S, 1), with the oval character "city" above and the feminine sign below. The word "Hamath" comes very near to one used in Hebrew for a bottle or bulging receptacle.

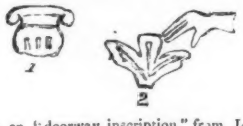


FIG. S.—Symbols on "doorway inscription" from Jerablûs: 1, vase or receptacle; 2, hand seizing vegetation.

The receptacle in the figure, having three vertical marks, and one or two horizontal marks, is a common symbol on the Jerablûs monuments. Probably, as in the bag previously spoken of (and see Fig. T), the three vertical marks denote objects within the receptacle; we may suppose, pieces of metal used as uncoined money. It seems most likely, however, that the difference in external shape of the receptacles indicates a difference in the nature and value of the contents. The symbol of seizing vegetation is another example of the use of ideograph or picture-writing in these inscriptions. That the thing seized is a plant or herb is sufficiently obvious. And from the accompanying symbols there is reason to think that one of the food-producing cereals, when ripe, is intended.

Treated in accordance with the principles which have guided us, and the conclusions previously expressed, the group of symbols concluding the "doorway inscription" in the British Museum will be found to yield probable and consistent results. Beginning from the reader's left, we have a symbol which, probably deriving its origin from the chase, bears some resemblance to the leg of an animal repeated, but inverted. The inverted position would appropriately represent the total defeat of an enemy,

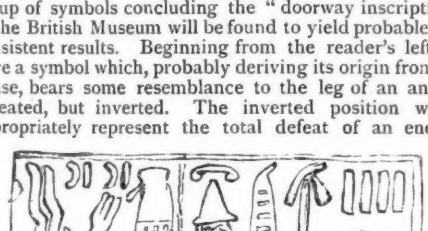


FIG. T.—End of "doorway inscription" from Jerablûs, in the British Museum.

while the repetition or doubling may be regarded as implying plurality, and perhaps flight. Then follow symbols denoting probably repeated thanksgivings to the gods (notice the doubling of the sign of deity). Next comes the bag of treasure with the hand beneath pointing towards the king. Under the king's head is a hand in the attitude of acceptance. Here is essentially what we find on the Yuzgât seal, but the object being accepted is not identical with the bag behind the king. Perhaps it denotes the tribute the payment of which was imposed on the conquered people.[1] Then follows the *shadoof* symbol, which here may well imply the vigorous prosecution of agriculture on the restoration of peace. At the end is the plant with four strokes above it, which may be regarded as signifying that the earth brought forth abundantly, or fourfold.[2] But whether the interpretation I have thus given is accepted or not, the ideographic character of the group is altogether unmistakable.

Allusion was previously made to the name "Zu-zu," or "Su-su" (see p. 539, note) as possibly occurring on the shortest (excepting mere fragments) of the inscriptions

[1] Having regard to the shape of the symbol, one may be reminded perhaps of the wool which was included in the tribute paid by Mesha of Moab to the king of Israel (II. Kings iii. 4).

[2] Cf. Amos i. 3 *seq.*, and the Biblical use of "four" and "fourfold."

from Jerablûs in the Museum. In the first line of the inscription is the most important of the places where the name would be thus read in accordance with the conclusions arrived at with regard to the Tarkutimme inscription. In the group there are two smaller cones and one larger, all crossed by horizontal lines. The two smaller cones will represent, as on the Tarkutimme inscription, a people or nation. This coincidence with the Tarkutimme inscription may give credibility to the supposition of still further agreement. The animal's head resting on the double cone will denote the name of the people. The taller cone would probably denote a king or possibly kings, crossed as it is by horizontal lines. A curve passes from the top down near the side of the taller cone, and above are the two strokes repeated and placed at an angle, which would be read "Zu-zu" or

FIG. U.—Group of symbols from Jerablûs monument in the British Museum.

"Su-su." Connected with the curve is an appendage passing to the head of an animal. Across this appendage (and the curve also after the two have become united) pass horizontal lines, probably lines of plurality. The animal's head, with the appendage, may give the name of a royal dynasty or possibly of a subordinate people.[1] But the chief interest attaches to the larger animal's head. In accordance with what was before said, we may regard it as tolerably certain that the name of the people is repeated. If "Zu-zu" is the correct reading of the strokes above the tall cone, the name of the animal whose head rests upon the double cone ought to be essentially the same. To solve the problem, if we are to be consistent, we must have recourse to the Semitic dialects, and preferably to Hebrew. Here we find a rare word, *ziz* (from a root *zuz* or *ziz*), used of an animal browsing sometimes on the vine (Psalm lxxx. 13, A.V.). It would be difficult to determine what particular species of animal is intended either in the Psalm or on the inscription; but it would seem not unsuitable to suppose that young wild cattle are intended in both. It will be in accordance with what has been said to identify "Zu-zu" with the Zuzim described in Genesis xiv. 5, as dwelling in the country east of the Jordan. And indeed, from an ancient city on the site of Jerablûs, a hostile raid on Bashan, Gilead, and the adjacent country was likely enough to be undertaken. Assyriological research has tended to show that Chedorlaomer and some other names in Genesis xiv. are genuine. It would not be very wonderful if the Hittite monuments should show that this is the case also with the name Zuzim.[2]

The results in decipherment thus set forth are, it may be said, but scanty and imperfect, and, in some cases, as based on slight evidence, may be liable to fall away when a wider induction is attainable. But "all science," it has been said, "is provisional"; and in relation to such a subject as that with which these articles are concerned, it may be sufficient if we should succeed in setting forth just principles, and in making even a slight extension of the boundaries of knowledge.

(*To be continued.*)

[1] It has been suggested that the smaller animal's head is that of a gazelle. If so, in the plural, the name would be in Hebrew "Tsebaim" or "Zeboim," a name found in Genesis xiv. 2, but possibly this would only be a curious coincidence.

[2] The city indicated on this monument, for the name of which I have suggested "Bamoth-elah" (*ante*, p. 539), may possibly be identical, judging from the ideograph, with Bamoth-in-the-valley of Numbers xxi. 20.

ASA GRAY.

THE following, as yet unpublished, words, almost the last spoken publicly by Asa Gray, have a pathetic interest for all those who knew and loved him. They were uttered in the Free Trade Hall, at Manchester, at the opening meeting of the British Association in August last, in seconding the vote of thanks to Sir Henry Roscoe for his address :—

"For the very great honour of being called upon to second the motion for a vote of thanks to your illustrious President, I am mainly indebted to that deference which is naturally accorded to advancing years, a deference which sometimes—as in the present case—takes one unawares.

'In looking back over the list of Corresponding Members of the British Association, I find myself, much to my surprise, nearly, if not quite, the oldest survivor.

"I recognize, therefore, a certain fitness, on this score, in the call upon me to be the spokesman of those, your brethren from other lands, who have been invited to this auspicious gathering, and to the privilege of listening to the very thoughtful, well-timed, and most instructive address of your President.

"As guests, we desire, Mr. Mayor, heartily to thank the city of Manchester and the officers of the Association for inviting us; we wish to thank you, Sir Henry, for the gratification your address has afforded us.

"Convened at Manchester, and coming myself by way of Liverpool, I would say personally that there are two names which memory calls up from the distant past with unusual distinctness; both names familiar to this audience and well known over the world, but which now rise to my mind in a very significant way. For I am old enough to have taken my earliest lessons in chemistry just at the time when the atomic theory of *Dalton* was propounded, and was taught in the text-books as the latest new thing in science.

"Some years earlier, Washington Irving in his "Sketch-book" had hallowed to our youthful minds the name of *Roscoe*, making it the type of all that was liberal, wise, and gracious. And when I came to know something of botany I found that this exemplar, as well as patron, of good learning had, by his illustrations of Monandrian plants, taken rank among the *Patres Conscripti* of the botany of that day.

"The name so highly honoured then we now honour in the grandson. And I am confident that I express the sentiments of your foreign guests, whom I represent, when I simply copy the words of your President in 1842, now reproduced in the opening paragraph of the address of the President of 1887, transferring, as we fitly may, the application from the earlier to the later Manchester chemist: 'Manchester is still the residence of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours due to a long career of persevering devotion to knowledge.'

"I cannot continue the quotation without material change. 'That increase of years to him has been but increase of wisdom' may indeed be said of Roscoe no less than of Dalton; but we are happy to know that we are now contemplating not the diminished strength of the close, but the manly vigour of the mid-course, of a distinguished career. Long and prosperously may it grow from strength to strength.

"In general, praise of the address which we have had the pleasure of hearing would not be particularly becoming from one whose chemistry nearly ended as well as began with the simple atomic theory of Dalton. But there is one topic which I may properly speak of, standing as I do as a representative of those favoured individuals whom your programme—for lack of a better distinguishing word—calls foreigners. I refer to the urgently expressed 'hope that this meeting may be the commencement of an international scientific organization.' For this we thank you, Mr. President, most heartily. This is, indeed, a consummation devoutly to be wished, and confidently to be hoped for, by all of us, especially by those for whom I am speaking. Not only we Americans, who are of British descent, and who never forget that blood is thicker than water, but as well our Continental associates on this platform, of the various strains of blood which interfused have produced this English race and fitted it for its noble issues—we, each and all, I repeat, accept this name of foreigners only in the conventional sense which the imperfection of language imposes. In the forum of science we ignore it altogether. One purpose unifies and animates every scientific mind with 'one divine intent,' and that by no means the 'far-off intent' of which the poet sings, but one very near and pervading. So we took to heart the closing words of your President's most pertinent and timely address. Indeed, we had taken them to heart in anticipation. And we have come to this meeting one hundred strong or more (in place of the ordinary score) fully bent upon making this Manchester meeting international.

"Far back in my youthful days there was a strong-willed President of the United States, of military antecedents, who once drew up and promulgated an official order which somewhat astounded his Cabinet officers. 'Why, Mr. President!' they said, 'you can't do that.' 'Can't do it!' replied General Jackson, 'don't you see that I have done it?' And so we internationals have come and done it. I am the unworthy spokesman of such a numerous, and such a distinguished array of scientific foreigners as have never been assembled before.

"Next year, if you will, you shall have as many more. When you, too, are ready to cross the Channel or the North Sea, we shall compose only a larger scientific brotherhood. And when you cross again the Atlantic, the brotherhood of science will be the more increased, and its usefulness in proportion.

"In behalf of your foreign guests, I heartily second the motion."

NOTES.

FIFTEEN years have passed since the Marshall Hall Fund was instituted with the twofold purpose of commemorating the late Dr. Marshall Hall, and for the encouragement of research in that branch of natural science which he did so much to develop. The Trust provides "that a prize shall be given every fifth year for the best original work done and recorded in the English language during the previous quinquennium, in physiological or pathological researches relating to the nervous system, and that the prize shall consist of the simple interest derived during the preceding five years from the amount of the capital fund." The first award was made to Dr. Hughlings Jackson, the second to Dr. Ferrier, and this year the Council of the Royal Medical and Chirurgical Society, in whose hands the Fund was placed, have awarded the prize to Dr. Walter Holbrook Gaskell, F.R.S., Lecturer in Advanced Physiology in the University of Cambridge. The Council have invited Dr. Gaskell to give some account of his work before the Society, and a special meeting will be convened for this purpose.

MR. MATTHEW ARNOLD, the tidings of whose death excited universal regret, did admirable service to the cause of education in England. No writer of his time pressed more earnestly on the attention of the public the need of thorough educational reform, and in his full and lucid Report on the Universities and secondary schools of the Continent he showed how far, in almost all matters relating to this essential element of the national life, we had allowed ourselves to be outstripped by some of our neighbours and rivals. Although, of course, convinced that

classical studies must be maintained in our schools and Universities, and personally interested chiefly in this aspect of the subject, Mr. Arnold frankly recognized the great place that must necessarily belong to science in any true system of education.

WE print elsewhere a letter from Emin Pasha. Other letters from him have lately appeared in the *Times* and the *Scotsman*. His province is evidently once more in working order, and Emin is at peace with his neighbours. The letters took eight months to reach this country, so we need not be alarmed by the fact that no word has come of Mr. Stanley's arrival. Emin tells us that the country through which Mr. Stanley had to pass is of the most difficult character, full of swamps, and with rivers rendered impassable by vegetation; so that the expedition could not reach the Albert Nyanza before November.

SO many new garden plants are annually described in various English and foreign periodicals that some are apt to escape the notice of botanists and horticulturists. From 1860 to 1886 a list was regularly published in the Gardener's Year-Book and Almanac; and during the months of January to May 1887 inclusive the *Journal of Horticulture* gave the names of plants up to October 1886. No later list has appeared. Now it has been decided that a list shall henceforth be given as one of the regular issues of the Kew Bulletin of Miscellaneous Information, and the first of the promised series is presented in the April number. It includes the new garden plants and alterations of names recorded between October 1, 1886, and December 31, 1887. To these have been added the names of authors, which did not appear in former lists. The list will be of great service to horticulturists.

ON April 8 a beautiful display of the aurora borealis was observed at Throndtjem. The weather was fine, and there was no wind.

ON March 12, at about 2 a.m., a faint shock of earthquake, accompanied by subterranean rumbling, was felt at Drammen, in Norway. It went from east to west.

A SEVERE earthquake occurred at Lintthal (Canton Glarus) on April 2, at 9.10 a.m. At Elm the oscillations were so strong that the walls of the houses were cracked.

ON the evening of Wednesday, the 11th inst., shocks of earthquake were felt in various parts of North Wales. At the large Baptist Chapel, Llangollen, while service was proceeding, a shock was distinctly felt, and the walls and ground were seen to shake. Shocks were also experienced at many of the residences in the valley, where the crockery and windows quivered in their places. A farmer residing at the Craig said his farmstead shook so much that he expected it to fall. The shocks were also noticed at Corwen, Bala, and Dolgelly.

SOME months ago a Conference was held in Manchester with the object of promoting the interests of the silk industries of the United Kingdom. Various papers were read, and it was ultimately resolved that an Association, to be called the Silk Association of Great Britain and Ireland, should be formed. The objects of the Association are to promote and maintain the silk industry of Great Britain and Ireland in all its branches; to encourage the production of raw silk in India and our colonies; to collect and disseminate amongst its members useful information and statistics connected with or affecting manufacture and commerce in silk; and to promote technical, commercial, and linguistic education, and any necessary Parliamentary legislation; and generally to assist in the expansion and development of the trade. The Association was "inaugurated" at Manchester on March 22, and will hold a general meeting in London in June.

IT is announced from Lyons that M. de Chardonnet has succeeded in getting by chemical processes a matter having all the appearance of silk. He adds to an etherized solution of nitrated cellulose (the base of gun-cotton) a solution of perchloride of iron, and to this mixture a little of a solution of tannic acid in alcohol. The whole is poured, after filtration, into a vertical reservoir having a horizontal sharp nozzle (with fine passage) at its base, debouching in a vessel of water acidulated with nitric acid. The issuing fluid vein at once becomes consistent, and can be drawn off by a uniform movement. It is dried by passage through a dry air space, and then wound. It is of gray or black a pect; but by means of colouring matter put in the etherized solution the colour may be varied *ad lib.* It is further described as supple, transparent, cylindrical or flattened; of silky appearance and touch; the rupturing weight is 25 kilogrammes per square millimetre. The fibre burns without the flame being propagated; it is unattackable by acids and alkalies of mean concentration, by cold or hot water, alcohol, or ether; but it is dissolved in etherized alcohol and acetic ether.

AN attempt was made last year to cultivate the cotton-tree in European Russia, in the neighbourhood of Taganrog, on the Don. We learn that the attempt proved successful, the temperature of the Lower Don being not inferior to that of the valleys south of the forty-first degree of latitude, where the cotton-tree is cultivated in Turkey.

THE Board of Trade Journal for April contains a paper in which there are some interesting facts about sponge-fisheries. It seems that an industry in artificial sponges is in process of creation. M. Oscar Schmidt, Professor at the University of Gratz, in Styria, has invented a method by which pieces of living sponge are broken off and planted in a favourable spot. From very small cuttings of this kind, Prof. Schmidt has obtained large sponges in the course of three years, and at a very small expense. One of his experiments gave the result that the cultivation of 4000 sponges had not cost more than 225 francs, including the interest for three years on the capital expended. The Austro-Hungarian Government has been so much struck with the importance of these experiments, that it has officially authorized the protection of this new industry on the coast of Dalmatia.

ACCORDING to *Allen's Indian Mail*, arrangements are now being made by the Meteorological Department of India for the prompt publication of a regular series of cyclone reports, so as to admit of their issue from two to three months after the date of the storm to which they refer. Hitherto, accounts of cyclones have not been published for a year or two after their occurrence.

THE *American Meteorological Journal* for March contains the first of a series of articles by Mr. A. L. Rotch on the organization of the Meteorological Services of Europe, based upon a similar series by Dr. Hellmann, about ten years ago, with the addition of subsequent changes. The first country dealt with is Germany. Of the other articles may be specially mentioned one by Mr. W. M. Davis, on a proposed classification of the winds, according to their physical causes and conditions. The characteristics employed are: (1) the source of energy that excites motion (earth, sun, &c.); (2) the contrasted temperatures (equator, poles, &c.); (3) the period of occurrence; (4) the kind of wind (cyclonic, sea-breezes, &c.). By this means, although no claim to novelty is made, except as to the arrangement of the data, the author proposes to bring together what is known into a convenient shape, and so to separate the unsorted material for further critical examination. Prof. H. A. azen continues the controversy between Dr. Hann and himself as to the behaviour of pressure and temperature in high and low barometric areas, at elevated stations; his theory being that

the low temperature in a cyclone at a mountain station is due to the lagging behind of the minimum pressure, and similarly with respect to the high temperature in an anticyclone.

AN interesting paper is contributed to the April number of the Journal of the Chemical Society by Mr. Ward Couldridge on chlorophosphide of nitrogen. This peculiar compound was shown some years ago by Dr. Gladstone to be represented by the empirical formula $PNCl_2$, but vapour-density determinations revealed the curious fact that in the gaseous state its molecule really possesses the constitution $P_3N_3Cl_6$. Mr. Couldridge prepares it by a method somewhat different from that employed by Dr. Gladstone, and one which gives a better yield. Pentachloride of phosphorus is heated with chloride of ammonium in a flask connected with an upright condenser, so that the pentachloride volatilized returns to the seat of action until it becomes completely decomposed, and the chlorophosphide, which would otherwise be carried away by the escaping hydrochloric acid, crystallizes in the condenser. The whole of the chlorophosphide is subsequently purified by distillation in steam. The reaction is found to be as follows: $3PCl_5 + 3NH_3 = P_3N_3Cl_6 + 9HCl$. Chlorophosphide of nitrogen thus prepared dissolves readily in ether, chloroform, or carbon bisulphide, and separates on evaporation in fine rhombic crystals, which have a most remarkable aversion to water, refusing under any circumstances to be wetted by it. When fused and heated above its boiling-point, it emits a singular odour. It has the proud distinction of being unattacked by all the strong acids, hot fuming nitric alone being capable of making any impression upon it. Mr. Couldridge finds that when dry ammonia gas is led through a hot tube containing the melted chlorophosphide, a somewhat violent reaction occurs resulting in the formation of another remarkable compound known as phospham, $P_3H_3N_6$ or $P_3N_3(NH)_3$. Not only does ammonia behave in this way, but all substituted ammonias, such as the amines, form similar compounds; aniline, for instance, gives a white solid, readily crystallizable from glacial acetic acid, of the composition $P_3N_3(NH . C_6H_5)_6$. Phospham itself is both insoluble in water and infusible at a red heat, but fumes in contact with air, owing to slow decomposition and oxidation. One cannot help remarking how singular it is that the introduction of phosphorus, itself a notable combustible, into the terribly explosive compound of chlorine and nitrogen, should result in the formation of a substance so extremely inert as the chlorophosphide; yet such are the vagaries met with by the chemist.

A SECOND edition of Prof. C. M. Tidy's "Hand-book of Modern Chemistry, Inorganic and Organic," for the use of students, has been issued by Messrs. Smith and Elder. As regards general arrangement, the author has adhered to the plan he first adopted. He especially notes that in writing of chemical compounds he has at times not hesitated to use common language. "If," he says, "I have used the word 'potash,' and the body I mean to imply thereby is understood, I am satisfied. I confess that the growing necessity for having a translation at one's side in attempting to understand the modern scientific paper, is in my opinion a circumstance to be deplored. Danger, moreover, is always to be apprehended when a language has to be invented to support a theory or a formula. A party shibboleth has, no doubt, a charm for its special clique. It serves as a bond of union for the initiated, whilst it prevents the interference of outsiders. But, all the same, it is distracting to the independent worker, and can but prove a hindrance to the general cultivation of science."

MESSRS. G. BELL AND SONS will shortly publish "The Building of the British Islands," a study in geographical evolution, by Mr. A. J. Jukes-Browne. The author tries to restore the geography of the British region at successive epochs of geological time, and to describe the gradual formation or evolution of the British Isles. The book will be illustrated by maps.

MESSRS. ROPER AND DROWLEY will publish immediately "Geology for All," by Mr. J. Logan Lobley, Professor of Physiography at the City of London College, and author of several volumes on geological subjects.

THE valedictory address delivered by Mr. J. W. Taylor as President of the Conchological Society has been reprinted from the *Journal of Conchology*, and issued separately. Mr. Taylor brings together some interesting observations bearing on the variation of British land and fresh-water Mollusca.

MR. THOMAS WILSON, of the Smithsonian Institution, calls attention in the *American Naturalist* to the fact that the importance of the subject of criminal anthropology has not hitherto been so thoroughly appreciated in the United States as in Europe. A step in the right direction, however, has been taken by the New York Academy of Anthropology, which lately held a meeting for the consideration of questions connected with criminal anthropology. These questions were classed under two heads, criminal biology and criminal sociology. In the circular summoning the meeting it was contended that the true way of studying crime is to begin with the study of the criminal himself. "It is impossible," said the writer, "to evolve the criminal out of one's inner consciousness. Knowledge of his peculiarities is essential to any rational treatment of him, and this knowledge can only be gained by systematic, intelligent observation of his physical and mental habits, supplemented by an exhaustive analytical comparison of the facts observed, with a view to their right classification and interpretation."

THE Mitchell Library, Glasgow, has now been ten years in existence, and the Committee, in the Annual Report just issued, express the belief that no consulting or reference library has ever made so much progress in so short a time. Speaking of the character of the reading, they say that it continues satisfactory, and bears evidence of a desire on the part of readers to seek solid information from the abundant resources at their disposal. Unfortunately, the Committee have to report that during 1887 twenty-one books were stolen.

THE Royal Microscopical Society will hold a *conversazione* on Wednesday evening, the 25th inst.

AN Aëronautical Exhibition was opened at the Rotunde in the Prater at Vienna on April 1.

THE additions to the Zoological Society's Gardens during the past week include an Arabian Baboon (*Cynocephalus hamadryas* ♀) from Massowah, presented by Mr. D. Wilson-Barker, R.N.R., F.Z.S.; two White-necked Crows (*Corvus scapulatus*), two Spotted Eagle-Owls (*Bubo capensis*) from South Africa, presented by Captain Henry F. Hoste, s.s. *Trojan*; a Muscovy Duck (*Cairina moschata*) from South Africa, presented by Mr. W. Shuter; four Half-collared Doves (*Turtur semitorquatus*) from Africa, presented by Mrs. Wisely; a Slowworm (*Anguis fragilis*), British, presented by Mr. F. W. Pilkington; two Indian Swine (*Sus cristatus* ♂ ♂) from India, a Greater Vasa Parrot (*Coracopsis vasa*) from Madagascar, a Blue-eyed Cockatoo (*Cacatua ophthalmica*) from South Australia, a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, an Asp Viper (*Vipera aspis*) from Italy, deposited; four European Pond Tortoises (*Emys europæa*), European, purchased; two Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

HARVARD COLLEGE OBSERVATORY.—The most interesting item in the forty-second Annual Report of the Director of the Harvard College Observatory is the account of the threefold accession to its resources which it has received during the past

year. This consisted of the funds provided by Mrs. Henry Draper for carrying on the photographic study of stellar spectra as a memorial to her late husband; the fund left by the late Uriah A. Boyden for the establishment of a mountain Observatory; and the large bequest of the late Robert Treat Paine. Prof. Pickering points out, however, that the Observatory still stands in need of further endowment, as its new resources are necessarily largely absorbed in those new lines of research for which they were specially designed, and considerable improvements are required in the principal building; and he adds that it is probable that there has never been a time in the history of the institution when so large a return could be obtained from a given expenditure as at present. The most striking results obtained during the year have been those secured by the use of the Henry Draper Memorial Fund in the photographic study of stellar spectra, and which have been already referred to in these columns. Under the Boyden Fund several instruments have been devised and constructed for the automatic registration of the meteorological conditions and general fitness for observing of sites for Observatories, and these have been carefully tested at various elevated stations. The usual observations have also been kept up, including the observation with the meridian photometer of the magnitudes of stars in zones at intervals of 5° in the region covered by the Southern D.M. This work was about half finished, and would, it was expected, be entirely completed within the present year. The east equatorial had been used in the observation of eclipses of Jupiter's satellites and of comparison-stars for variables. A wedge photometer, arranged in a somewhat modified manner, is employed with this telescope, and is to be used in the investigation of the phases of asteroids and in the observation of zones of D.M. stars. The meridian circle is to be engaged in the observation of one of the zones required in the proposed revision of the Southern D.M.

COMET 1888 *a* (SAWERTHAL).—Dr. L. Becker has computed the following elements and ephemeris from observations made on February 18 at the Cape, March 13 at Palermo, and March 27 at Strasburg. From the outstanding deviation of the middle place it may be inferred that unless there be some considerable error in the observations the true orbit will prove to be elliptical.

T = 1888 March 16·96412 G.M.T.

$$\left.\begin{aligned} \pi - \Omega &= 359^\circ\ 49'\ 45''\!\cdot\!1 \\ \Omega &= 245\ 30\ 40\cdot2 \\ \iota &= 42\ 17\ 47\cdot4 \end{aligned}\right\}\ \text{Mean Eq. 1880·0.}$$

$$\log q = 9\cdot844562$$

Error of middle place ($O - C$).

$$\Delta\alpha \cos\delta = -\ 2\cdot61\text{s.} \quad \ldots \quad \Delta\delta = +\ 7''\cdot1.$$

Ephemeris for Greenwich, Midnight.

1888	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.	Brightness.
April 20	22 57 31	20 22·7 N.	0·1517	9·9912	0·3
22	23 2 48	21 44·3			
24	23 7 58	23 2·3	0·1681	0·0143	0·3
26	23 13 3	24 16·9			
28	23 18 2	25 28·3	0·1835	0·0369	0·2
30	23 22 55	26 36·7			
May 2	23 27 41	27 42·2 N.	0·1980	0·0588	0·2

The brightness at discovery is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *APRIL* 22–28.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 22

Sun rises, 4h. 50m.; souths, 11h. 58m. 21·1s.; sets, 19h. 6m. right asc. on meridian, 2h. 2·2m.; decl. 12° 26′ N. Sidereal Time at Sunset, 9h. 11m.

Moon (Full on April 26, 6h.) rises, 14h. 3m.; souths, 21h. 7m.; sets, 3h. 56m.*: right asc. on meridiar, 11h. 12·3m.; decl. 8° 39′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	4 31	10 52	17 13	0 55·3	3 21 N.
Venus ...	4 21	10 40	16 59	0 44·1	3 2 N.
Mars ...	17 24	23 1	4 38*	13 7·0	5 12 S.
Jupiter ...	21 56*	2 10	6 24	16 12·7	20 8 S.
Saturn ...	10 7	18 5	2 3*	8 9·5	20 44 N.
Uranus ...	17 11	22 49	4 27*	12 54·3	5 4 S.
Neptune..	6 1	13 43	21 25	3 47·6	18 18 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

April.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
22	B.A.C. 3837	6	18 9	19 32	90 173
25	65 Virginis	6	4 19	near approach	17 —
28	χ Ophiuchi	6	5 46	6 44	96 316

April.	h.	
24	22	Mars in conjunction with and 3° 16′ south of the Moon.
28	1	Jupiter in conjunction with and 3° 26′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl.		h. m.	
U Cephei	0 52·4	81 16 N.	Apr. 22,	3 21	*m*
U Virginis	12 45·4	6 10 N.	,, 23,		*m*
V Boötis	14 25·3	39 22 N.	,, 27,		*M*
δ Libræ	14 55·0	8 4 S.	,, 24,	22 4	*m*
U Coronæ	15 13·6	32 3 N.	,, 24,	1 14	*m*
S Coronæ	15 16·8	31 46 N.	,, 25,		*M*
U Ophiuchi	17 10·9	1 20 N.	,, 22,	0 38	*m*
			,, 27,	1 24	*m*
β Lyræ	18 46·0	33 14 N.	,, 22,	3 0	*M*
U Capricorni	20 41·9	15 12 S.	,, 26,		*M*
T Vulpeculæ	20 46·7	27 50 N.	,, 23,	2 0	*m*
δ Cephei	22 25·0	57 51 N.	,, 22,	21 0	*m*
S Aquarii	22 51·1	20 56 S.	,, 23,		*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

THE death is announced of Nicholas von Miklucho-Maclay, at the age of forty-two years. M. Maclay's name must be familiar to our readers in connection with New Guinea explorations. He was the son of a Russian nobleman, and studied medicine and natural science at St. Petersburg and at several Dutch Universities. In 1866 he accompanied Prof. Haeckel to Madeira; in 1867 he visited the Canary Islands, and, in 1869, Morocco. He then made preparations for an extended exploration among the Pacific Islands, and especially in New Guinea. He went by South America, Tahiti, and Samoa to New Guinea, and remained for over a year, 1871–72, on its north-west coast, afterwards exploring the south-west coast to the south of Geelvink Bay. In 1874–75 he visited Further India, and especially Malacca, where he explored several districts in the interior, and obtained important results. After visiting the Pelew, Admiralty, and other island groups, Maclay again went to New Guinea (1876–78), devoting himself to the north coast, where he was now well known, and was on friendly terms with several Papuan tribes. Maclay then went to Singapore and Sydney to restore his shattered health, but was in New Guinea again in 1879, afterwards visiting several Pacific islands and going on to Sydney once more. He returned to Russia in 1882, bringing with him rich collections in ethnography and in natural history. M. Maclay afterwards resided for some time in Sydney, where he founded a biological station. He recently returned to Russia, and at the time of his death, we understand, was preparing for publication a complete account of his many years' work. At present the records of his travels, with their rich anthropological results, are to be found mainly in the Proceedings of the Batavia Society and the Russian Geographical Society.

WE also learn of the death of Herr Anton Stecker, who has done some good exploring work in Africa. In 1878 he accompanied Rohlfs to Kufra, and in 1880 he went out at the expense

of the German African Society to Tripoli, and thence by Egypt and Abyssinia to Galla Land. Herr Stecker's observations referred largely to natural history, of which he was a student.

LIEUT. WISSMANN, the African traveller, who was obliged to spend the winter at Madeira on account of ill-health, there had an opportunity of writing the report of his second journey to Africa. The book has just been published by Brockhaus. At present Lieut. Wissmann is engaged on an account of his first expedition to the south of the Congo Basin, in company with Dr. Pogge.

DRS. FRIEDERICH KURTZ AND WILHELM BODENBENDER, both Professors at the Cordoba University (Argentine Republic), have started on a scientific expedition to the East Andes.

FORESTRY IN THE CAPE COLONY.

THE Report of Consul Siler, the United States representative at Cape Colony, which has been just issued, contains a full account of the present state of forestry in that country. He says that of the 214,000 square miles which are comprised in Cape Colony, there are something over 350 square miles covered with large forest trees. These forests lie almost all together near the sea, running nearly parallel to the coast, in the temperate regions of the southern mountain chains. Till recent years the system of felling pursued was a most wasteful and unsystematic one. Far from confining the operations of the woodcutters to certain limited sections or areas, the authorities permitted them to roam about at pleasure, and to pick and choose from among the forests what trees they should cut down. This license had its natural effect: only the choicest trees were cut, and even of these only selected portions were taken away, the rejected parts being left to cumber the ground. It has been estimated by those skilled in woodcraft that by this pernicious system 30 cubic feet of wood were wasted to each one utilized; and thus it is that many forests have totally disappeared, and even those that were not so easily accessible have been sadly impoverished. Till 1880 no steps were taken to preserve this natural wealth that was being so shamefully abused. In that year, however, the question was strongly urged on the attention of the Colonial Parliament. One of the chief defects of the system was pointed out—namely, the total absence of skilled caretakers, those then in charge having received no technical education whatever; and to meet this in some measure Parliament at once voted a sum of money to pay a trained superintendent. The choice fell on Count de Vasselot, who had had wide experience in French forestry at Nancy, and he at once proceeded to lay the foundations of the present forest department at the Cape. One of his first steps was to divide the forests into districts, which he again subdivided into sections, and to direct that felling should proceed in sections, the re-growth of the first section being given time to develop into mature trees before the axe was again used in that section. By this system the entire shutting up of any forest for a time is done away with. At present the period for the "revolution" of fellings is fixed at forty years. The tariffs now vary for standing timber from 2 cents to 6 cents per cubic foot of sound wood; with the exception of stinkwood (*Oreodaphne bullata*), which, being very hard and very valuable, was almost threatened with extermination, for which the price is 24 cents per cubic foot. Poles from 6 inches to 10 inches in diameter are sold at the rate of 2 cents per running foot; spars from 4 inches to 6 inches in diameter at 12 cents per 100 running feet.

The Consul illustrates the general system of managing and preserving the forests now followed in the colony by a minute description of that used in Knysua, the most extensive and most valuable of all the Cape forests. The total area of the Knysua may be roughly stated to be 100,000 acres, and of this magnificent forest almost three-fourths have been impoverished and in fact exhausted by the indiscriminate and reckless system of felling pursued in the past. At present the staff to conserve and replant this forest consists of one conservator, three superior grade officers, and six rangers or guards. Each higher grade officer has the superintendence of a tract of woodland varying in extent from 10,000 to 30,000 acres, in which he surveys the large timber, fixes the limits of the blocks or series, and plans out the boundaries of the various sections. No works are sanctioned without the consent of the Superintendent of Woods and Forests, and, if he has given his approval, the sections are surveyed and the trees fit for felling are marked with an official stamp. The duties of the rangers are to ride about their districts and endeavour to discover any breaches of the forest regulations, and in cases of successful prosecution they are rewarded according to the zeal and ability displayed by them. Besides the officers above-named, there are thirteen foresters distributed over the different woods, whose duty it is to plant, and, if necessary, transplant trees, and to take care of young trees. These men are paid at the rate of $20 a month, are provided with free quarters and ten acres of garden land, and are paid a bonus of $2.50 per 1000 for planting nursery plants, $2.50 per 1000 for 1-foot trees in the forest, or for nursery work and transplanting $5 per 1000 trees. This bonus cannot in the case of any individual forester exceed $200 in the year, without special permission. Each forester is expected to raise at least 40,000 young trees annually. So far as can at present be judged, seeing that the system has had but a few years' trial, it has undoubtedly proved a success. To show the amount of work that some of these foresters get through, it may be mentioned that in King William's Town forests in the year 1885 six foresters planted in the course of the year 138,080 plants in the nursery, and transplanted from the nursery into the forests 63,885 young trees. With the object of encouraging these valuable efforts to preserve the forests and to increase the area under timber, the Colonial Government has laid out several large tracts of land into plantations and nurseries, and although these are but of very recent formation they have already proved their utility in the reafforesting of the country. At the Government nurseries there are at the present moment over one million plants flourishing. In the working of these nurseries and plantations, convict labour has been utilized as largely as possible, and by this means the cost of the convict prisons has largely diminished. One other work in this connection of the Colonial Government is worthy of remark. At the plantation of Tokai, on the Table Mountain range, 150 species of extra-tropical trees have been introduced, and from them plants have been raised, with which it is proposed to reafforest the whole Table Mountain slopes, and already, in the short space of two seasons, 1000 acres have been replanted. From all the Government nurseries plants can be purchased at a nominal rate, and this, together with a recent Act whereby public bodies receive Government aid to the extent of one-half their expenditure on replanting, has given a strong stimulus to, and has aroused general interest in, the science of arboriculture among the colonists. Following the example of many American States, their first "arbor day," in 1886, was proclaimed a public holiday; and so great was its success that it is very likely to become a permanent institution. The Consul concludes his Report by saying that it is confidently hoped that with such machinery at work and with a growing interest in the advantages of tree-cultivation, in the future, Cape Colony will be independent of foreign markets for her timber supply; and that it is probable that the presence of forests, by increasing the rainfall, will bring tracts which are at present barren into cultivation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 22.—"On the Skull, Brain, and Auditory Organ of a new Species of Pterosaurian (*Scaphognathus Purdoni*) from the Upper Lias, near Whitby, Yorkshire." By E. T. Newton, F.G.S., F.Z.S., Geological Survey. Communicated by Dr. Archibald Geikie, F.R.S.

The fossil Pterodactyl skull, which is the subject of this communication, was obtained from the Upper Lias of Lofthouse, near Whitby, by the Rev. D. W. Purdon, of Wolverhampton. It is the first Pterodactyl found in the Yorkshire Lias, and is a new form, allied to the Continental Jurassic species *Scaphognathus* (*Pterodactylus*) *crassirostris* of Goldfuss. The structure of the skull, including the back, base, and palatal regions, is better shown than in any previously discovered specimen; and in addition to this the brain and parts of the auditory organs have been exposed.

In its present condition the skull is about five and a half inches long; but apparently about two inches of the front are wanting. The elongated snout gives the skull a very bird-like appearance; but its most striking features are the five apertures, surrounded by bone, seen on each side. The orbit is the largest of these apertures; in front of this, and next in size, is the ant-orbital fossa; still further forward is the somewhat smaller external

nostril. Behind the orbit is the temporal space, divided by a bony bar into the supra- and infra-temporal fossæ.

On the upper surface of the skull are to be seen the nasals and prefrontals, on each side of the premaxillary process. The frontals form the upper boundaries to the orbits, and are confluent posteriorly with the parietals. Strong buttresses extend outward from the postfrontal and parietal regions to form the supra-temporal bar. There is on each side a large lachrymal bone forming the greater part of the upper and hinder boundary of the ant-orbital fossa. The jugal and quadrate-jugal are of a somewhat unusual form; the former bounding the lower half of the orbit, and the latter inclosing in an open **V** the greater part of the infra-temporal fossa. The quadrate is a wide but thin plate seen chiefly at the back of the skull. The base of the cranium is remarkable for its depth and extreme antero-posterior flattening; and viewed from behind a pair of long rods are seen extending from its lower margin, one on each side, to the inner angles of the quadrates. These bones are regarded as the homologues of the basi-pterygoid processes of the sphenoid, such as are seen in some lizards and birds, as for example in the Chameleon and Emu.

From the point of junction of the quadrate and basi-pterygoid process a bone runs along the palate, and dividing anteriorly forms the hinder boundary of the internal nostril, its outer portion joining the maxilla and its inner being continuous with a median bone occupying the position of a vomer. This bony bar, it is thought, represents the palatine and pterygoid bones.

The back of the skull is essentially Lacertilian. A large paroccipital bone extends outwards from the sides of the foramen magnum, and its distal end, expanding, embraces the upper part of the quadrate. The relation which the base of the paroccipital bears to the semicircular canals shows that it must be chiefly formed by the opisthotic element, as Prof. W. K. Parker has shown to be the case in lizards, and not by the exoccipital as it is in birds.

By removing the frontal and parietal bones of the left side, a cast of the brain cavity has been exposed, which there can be no doubt represents the form of the brain, just as closely as does that of a bird's cranial cavity. In proportion to the size of the entire skull, the brain of this Pterodactyl is very small, being not more than one-eighth of its length. Each cerebral lobe is oval in shape, and about as thick as it is wide. The olfactory lobe is small. Behind the cerebrum is a pair of large optic lobes, occupying a prominent position on the sides of the brain, and extending upwards well to the upper surface, but not meeting above in the middle line. The region of the cerebellum has been broken away, and its exact form therefore is somewhat uncertain; but, judging from portions which remain, it is tolerably clear that it extended between the optic lobes, and may have reached as far forwards as the cerebrum. Attached to the side of the medulla oblongata is a large flocculus, such as occurs in this position in birds.

It was the finding of the flocculus which led to the discovery of some parts of the auditory apparatus. On clearing away the stone in this region, a small tube filled with matrix was found arching over the pedicle of the flocculus and dipping down between it and the optic lobe. This tube occupies the position of the anterior vertical semicircular canal in the goose. By tracing the canal backwards and downwards it was found to join another similar tube forming an arch behind the flocculus—that is, in just the position of a posterior vertical semicircular canal. By careful excavation below the flocculus, a portion of a third tube was found, arching outwards in a horizontal plane, and this is believed to be the external semicircular canal.

The similarity between the base of the fossil skull and that of the Chameleon led to the inference that the fenestra ovalis would be found to be similarly placed in both, and by clearing away the matrix from the orbit and temporal fossa this inference was proved to be correct. The form and relations of the quadrate bone make it highly probable that this Pterosaurian had no eardrum.

A comparison of this fossil with the skulls of known Pterosauria leaves no doubt that it is more nearly related to the *Scaphognathus* (*Pterodactylus*) *crassirostris* than to any other species, but as it differs from that form, and is evidently new, it is to be named specifically *Scaphognathus Purdoni*.

The Pterosaurian skull, as exemplified by this Lias fossil, resembles more the Lacertilian than any other type of Reptile skull; and seeing that the skulls of birds and lizards are in many points very similar, one is not surprised to find in this fossil characters which are also found in both these groups. In considering, therefore, the relation which the Pterosaurian skull bears to those of birds and lizards, the characters should be especially noticed which serve to distinguish between the two groups, thus:—

1. In birds the brain-case is larger in proportion to the size of the skull than it is in lizards.

2. The quadrate, pterygoid, and palatine bones are movable on the skull in birds, but more or less fixed in lizards.

3. In birds the hinder end of the palatine and front end of the pterygoid are brought into close relation with the rostrum of the sphenoid. This is not the case with lizards.

4. The orbit is rarely completed by bone in birds, and never by the jugal; in lizards the orbit is surrounded by bone, and the jugal forms part of it.

5. In birds there is no prefrontal bone, while it is always present in lizards.

6. No bird has a supra-temporal bar of bone, but it is always developed in lizards.

7. In lizards the paroccipital process is large and formed by the opisthotic; in birds the paroccipital is small and formed by the exoccipital.

8. In birds the bones of the cranium are early anchylosed; in lizards they nearly always remain separate.

9. Birds have the premaxillæ large and united into one bone; in lizards they are usually small.

10. The ant-orbital fossa which is present in birds is only occasionally present in lizards.

11. In birds there is always a lower temporal bar of bone extending from the maxilla to the quadrate. This bar is incomplete in all lizards except *Sphenodon*, although well developed in other reptiles.

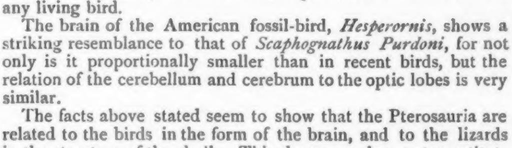
The skull of *Scaphognathus Purdoni* agrees with lizards in the first seven of the above characters; and with birds in those numbered 8, 9, 10. Number 11 need not be considered, as it can scarcely be regarded as distinctive. The greater importance of the first seven characters makes it clear that in the structure of the skull *S. Purdoni* most nearly resembles the Lacertilia.

The brain of *Scaphognathus Purdoni* agrees with that of reptiles in its relatively small size; while the separation of the optic lobes by the cerebellum and the meeting of the latter with the cerebrum, as well as the possession of a distinct flocculus, are important points in which it resembles the brain of the bird. On the other hand, the form of the optic lobes is unlike that of any living bird.

The brain of the American fossil-bird, *Hesperornis*, shows a striking resemblance to that of *Scaphognathus Purdoni*, for not only is it proportionally smaller than in recent birds, but the relation of the cerebellum and cerebrum to the optic lobes is very similar.

The facts above stated seem to show that the Pterosauria are related to the birds in the form of the brain, and to the lizards in the structure of the skull. This, however, does not constitute the Pterosaurian a transitional form between birds and reptiles, in the sense of the Pterosauria having been derived from reptiles, or of the birds having been derived from Pterosauria; but rather points to *Aves*, *Pterosauria*, and *Reptilia* having been derived from some common ancestral type. These relationships may be thus indicated, taking only a few of the characters of each:—

Lizard.	*Pterosaurian.*	*Bird.*
Cerebellum small, optic lobes meeting, paroccipital formed chiefly by the opisthotic.	Cerebellum large and between optic lobes, paroccipital formed chiefly by the opisthotic.	Cerebellum large and between optic lobes, paroccipital formed chiefly by exoccipital.



Ancestral Type.

Cerebellum small, optic lobes meeting, paroccipital small, and formed by both exoccipital and opisthotic.

Mathematical Society, April 12.—Sir J. Cockle, F.R.S. President, in the chair.—The following communications were

made:—Continuation of a former paper on simplicissima, by W. J. C. Sharp.—Synthetical solutions in the conduction of heat, by E. W. Hobson.—Symmetric functions, part ii., by R. Lachlan.—On a law of attraction which might include both gravitation and cohesion, by G. S. Carr.—Messrs. Buchheim, Larmor, and Greenhill spoke upon the various papers.

PARIS.

Academy of Sciences, April 9.—M. Janssen, President, in the chair.—Observations of the minor planets made with the great meridian instrument of the Paris Observatory during the third and fourth quarters of the year 1887, by M. Mouchez. The right ascension, polar distance, and correction of ephemerides are tabulated for thirteen of the minor planets.—On Gompertz and Makeham's laws of mortality, by M. J. Bertrand. Some arguments are advanced to show that, although he does not mention them, Thomas Simpson must have been acquainted with one or both of these laws.—Observations on the fixation of nitrogen by certain vegetable soils, by M. Berthelot. Some remarks are made in connection with the author's previous communications and M. Schlœsing's recent notes on this subject. It is pointed out that M. Schlœsing has not taken sufficient account of the experimental conditions which M. Berthelot has shown to be necessary in dealing with the question of nitrification.—On a new gas-thermometer, by M. L. Cailletet. This instrument, which has been for some time employed by the author, especially in connection with his researches, jointly made with M. Bouty, on the measurement of electric resistances at low temperatures, is described as of an extremely sensitive character, indicating differences of height of 2·36 millimetres for 1° of temperature. Being intended for measuring extremely low temperatures, it is charged with hydrogen as the expanding body.—Report on M. Delauney's astronomical communications, by the Commissioners, MM. Daubrée, Tisserand, and Faye. These communications, which were addressed to the Academy during M. Delauney's residence in Cochin-China, are now resumed in one volume, and are of an extremely varied character. They deal with the distances of the planets from the sun; the distances of the satellites from their respective planets; the distances of certain stellar groups from the central orbs of their systems; the distance of aërolites from the sun, their action on the solar spots, on our volcanoes, on the meteorological phenomena of our atmosphere, and on terrestrial magnetism; formation of the stellar systems, and especially that of Sirius, of which the sun itself, with Procyon, α Centauri, Vega, Arcturus, and others, would appear to be members. These, and other even bolder speculations, seem based on the three laws of distances here formulated by the author.—Observations of Sawerthal's Comet 1888 *a* made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan, and at the Bordeaux Observatory (0·38 m. equatorial), by MM. G. Rayet and Courty. The Paris observations cover the period from March 25 to April 6; those of Bordeaux from April 4–6.—Observations of Palisa's new planet, discovered April 3, 1888, made at the Observatory of Algiers with the 0·50 m. telescope, by MM. Trépied and Sy. These observations, made on April 4, give an estimated magnitude of 12·5 for this planet.—On M. Bertrand's geometrical curves, by M. G. Demartres. These curves are here considered as geodetic lines of ringed surfaces, and the following problem is proposed and discussed: To find the surfaces whose circular generator is inclined at the same angle, *i*, on the same family of geodetic lines, this angle, however, being capable of varying from one generator to the next.—Action of the tetrachloride of carbon on oxygenated mineral compounds free of hydrogen, by M. H. Quantin. It was long ago shown by Geuther that potassa and baryta raised to a red heat in the vapour of the tetrachloride of carbon are transformed to chlorides and carbonates. More recently the experiments of Demarçay and Quantin, since confirmed by Lothar Meyer, have shown that oxides which cannot be attacked by chlorine alone are under the same conditions also transformed to chlorides. In the present paper the author deals more fully with these phenomena, and generalizes the results already obtained.—On the sesquichloride of rhodium, by M. E. Leidié. After examining the processes hitherto employed in the preparation of the anhydrous sesquichloride, the author describes a new method in which the chlorine acts on the alloy of rhodium and tin, $RhSn_2$, described by Debray. He then gives the processes of preparation of some double chlorides formed by the hydrated sesquichloride.—On the passive property of nickel, by M. Ernest Saint-Edme. Having already described the results of his researches on the passivity of steel and iron, the author here deals with some of the conclusions he has obtained from the analogous study of nickel.—Action of the cyanide of zinc on some chlorides, by M. Raoul Varet. The results are described of experiments with the chlorides of mercury and copper, as well as with the alkaline chlorides. The general conclusion is arrived at that the cyanide of zinc does not enter into molecular combination with the chlorides.—Syntheses by means of cyanacetic ether (continued), by M. Alb. Haller. In the present paper the author deals with the higher homologues of acetylcyanacetic ether.—Heat of formation of aniline, by M. P. Petit. The heat of formation of aniline is here determined, both by the wet and dry processes, with fairly uniform results.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

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